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AND

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NOTES AND COMMENTS.

Birmingham Foundrymen.

Herewith is given the programme of lectures and other fixtures in connection with the Birmingham Branch of the British Foundrymen's Association. This is one of the most successful Branches in the kingdom, and the meetings in the past have proved highly attractive. The Branch has the merit of financial soundness, having finished its work last year with a balance in hand. The Secretary of the Branch is Mr. C. Heggie, 76, Hillaries Road, Gravelly Hill, who may be applied to for further information, or to arrange future memberships.

The programme for the session just entered upon is as follows:—

1908.

October 24.—"Presidential Address" (Mr. R. Buchanan, F.R.S.A.).

November 28.—"Brass Founding," by Professor T. Turner, M.Sc., A.R.S.M., F.I.C. (joint meeting with Birmingham Metallurgical Society).

December 12.—"Coke Consumption in Cupola Practice," and General Discussion.

1909.

January 23.—"Bearing Metals," by Mr. A. H. Hiorns.

January 29.—"The Static and Dynamic Testing of Metals," by Professor J. O. Arnold (Birmingham Metallurgical Society Lecture).

February 27.—"The Mixing of Irons for Casting," by Mr. G. Hailstone.

March 27.—"Malleable Cast Iron" by Mr. J. Matthews.

April 24.—"The Use of High Temperatures in the Metallurgy of Iron" (demonstrated with the electric furnace), by J. H. Stansbie, F.I.C., B.Sc. (London).

May 1.—Annual general meeting and smoking concert.

May 22.—"Mechanical Testing in the Foundry," by Mr. F. J. Cook.

Several interesting visits have also been arranged.

Proper Foot Gear in the Foundry.

Herr Niese, an engineer, read before one of the German societies a paper on the above subject, which should be of interest to all iron foundries. It referred more particularly to the great number of accidents taking place in foundries by reasons of burns caused by melted metal. Most such accidents are caused by the metal burning through the clothing, and, by reason of the resistance of the cloth, not being able to be removed soon enough. As it is mostly the feet and legs of the workmen which are injured, it is well that special attention should be given to the subject of proper covering for the feet. Founders have different opinions about what is best to wear. Some prefer strong laced shoes; many make it imperative that their workmen wear such as may be readily and quickly removed in case of accident. In Germany workmen wear, very largely, wooden shoes, or those having wooden soles and leather uppers; these are unfavourable because the liquid metal can very easily get into them, and in such accidents as occur in carrying a ladlefull of melted metal the consequences are very serious. They have, however, the advantage that they can readily and quickly be thrown off.

One of the co-operative societies in Germany took the trouble to collect statistics concerning this question. Two hundred and forty-seven question sheets were answered by members, concerning as many cases of burned feet. Of these 244 were from melted iron and three from other molten metals. The molten metal came in 238 cases from ladles, in nine from crucibles. Forty-three cases took place at the cupola, 109 in carrying the material, and 95 in pouring. There were 109 instances where the right foot was burned, 121 where the left was burned, and 17 for both.

The number of foundry workmen who were questioned as to their foot gear was 9,148. Of these :—

1,613 or 17.6 per cent. wore boots with elastic sides.
1,357 or 14.8 per cent. wore long boots.
500 or 5.5 per cent wore wooden boots.
222 or 2.4 per cent. wore buckled boots.
435 or 4.8 per cent. wore wooden slippers.
4,008 or 43.8 per cent. wore laced boots.
1,013 or 11.1 per cent. wore low shoes.

Of the 247 men incurring burned feet :—

17 or 6.9 per cent. wore gaiters.
21 or 8.5 per cent. wore long boots.
9 or 3.6 per cent. wore wooden boots.
4 or 1.6 per cent. wore buckled boots.
10 or 4.1 per cent. wore wooden slippers.
145 or 58.7 per cent. wore laced boots.
41 or 16.6 per cent. wore low shoes.

From these figures it would appear that for foundry work the "Congress gaiters" or shoes with elastic sides are the least dangerous, and the "low shoes" the most. If the danger from the "Congress gaiters" is represented by 1, that from long boots is 1.71, from buckled boots 1.71, from wooden slippers 2.19, from laced boots 3.45, and from "low-shoes" 3.86.

While there may be some who would doubt the accuracy of these percentages as representing foundries in general, it is evident that the matter is worthy of close attention, and it would prove interesting were a census of similar accidents in British foundries taken.

Air and a Foundry Blower.

As an instance of how a simple thing will hamper the successful working of a cupola, may be taken an incident which occurred in a foundry recently. The blower supplying air to the cupola was placed in a wooden house. The foundry foreman complained that his metal took a long time to melt, and came down very stiff and cold. No cause for the trouble could be discovered, and the firm who supplied the blower had to send their expert to investigate. He arrived whilst a blow was in progress, and stood for some time watching the stiff metal being run. Then he visited the blower, and finding all apparently in order, returned shortly to the tapping ladle. To everybody's surprise the metal began to come down hot and fast. Further investigation showed that the only change was that the expert had left the door of the blower house open, whereas the cupola attendant had been in the habit of closing it. When he closed the door the air supply to the blower was affected, and the result was very soon felt in the cupola.

Light Steel Castings.

An American writer dealing with the question of light steel castings and odd shapes remarks on the relatively high cost through losses in the foundry and rejection of the castings by customers on account of defects. While, he says, in a

foundry producing a fairly regular class of work and with perhaps a large proportion made on moulding machines, the percentage of good castings will be high, the average general or jobbing shop with a great variety of shapes will often not secure much more than 50 per cent. of actual saleable castings from the metal melted. The difference between metal charged and metal yielded varies with the shape and character of the castings turned out. Car fittings, such as bolsters, truck frames, etc., for both freight and passenger service, are comparatively light in weight, and will average about 600 lbs. per casting. The loss in gates and risers on such designs is practically 7 per cent. Adding to that the loss in melting, skulls, fins, and bad castings it is comparatively easy to show a yield of 68 per cent. of metal charged as good castings, because that kind of product does not greatly decrease the yield through a heavy loss in gates and risers. But there are steel foundries producing work which may vary from a small gear to the head of a moulder's rammer or the sternpost of a "Dreadnought." The weight per casting may vary from a pound or two up to 100,000 lbs. In such a case a month's run may show a yield of only 55 per cent. of good castings from metal charged. The loss in bad castings does not exceed 5 per cent., but owing to a great many heavy castings, the loss in gates and risers is excessive. Large, massive castings require large, massive risers; bolsters, truck frames, knuckles, and drawbars require small, light risers, and in some cases no risers at all. Take, for instance, a locomotive frame weighing 6,000 lbs. Such a casting necessitates a gate and risers totalling 2,000 lbs. An unavoidable loss of 33 per cent. in non-saleable metal.

A foundry report showing a certain loss in defective castings during a certain period may fluctuate through a variety of causes. A loss of one large casting would make a disastrous showing.

It is claimed by many that open-hearth methods, like the Bessemer process, have practically reached the limit in the matter of quality, and that the product of to-day is the best that can be made with the materials and fuels available; that steps in open-hearth practice for future developments must come in the form of reducing the cost of repairs, simplifying the operation of furnaces, lengthening their life, and producing larger tonnages with greater speed. Further, the electric process is urged as an alternative whereby greater economy may be attained, owing to the higher standard of purity obtainable in the metal. But it must be remembered that faults can occur with the electric furnace and produce results equally as bad at times as can the open-hearth, the converter or the crucible. Granted that the electric furnace offers a possibility of yielding steel of greater purity and better quality than is possible by other methods of steel manufacture, that would not make the moulder commit fewer errors, cause castings to strip more cleanly of burned sand, eliminate shrinkage and its attendant evils and lessen losses resulting from gates and risers.

The employment of the electric furnace for the production of steel castings is steadily gaining ground, and in many cases has proved more economical than other methods. Not only where power can be generated satisfactorily by the users, but also where any good supply of cheap current is available, the electric furnace has proved successful. It does not do to generalise in the matter of successful working, however, for each different class of furnace has its own merits, which must be duly considered in conjunction with the work to be turned out before an installation is decided upon.

Magnesium in Bronze.

The fact that magnesium is such a strong deoxidising agent has rendered it valuable in making sound copper castings. Although tried in bronze and brass, the results first obtained were unsatisfactory, as the use of a large quantity of any deoxidising agent is often detrimental. Some recent experiments made with magnesium in bronze sand castings demonstrate that in small quantities it has a beneficial effect. The metal is very close-grained and has physical properties superior to metal without it. The quantity added was 0.05 per cent., which is amply sufficient for deoxidising purposes. Probably half this quantity would give even better results in alloys which contain zinc, such as brass or bronze, for the reason that there is less oxide to be reduced than in metals like copper or nickel. As magnesium is a metal, it is, theoretically, a better deoxidising material than a non-metallic substance like phosphorus.

MOULDING AND CASTING IRON BATHS.

J. PETIN, "Giesserei Zeitung."

THE manufacture of cast-iron baths is a speciality of certain foundries connected with enamelling works, the combination being essential because most of these baths are sold in an enamelled condition. Until quite recently, these baths were moulded by hand entirely; but of late successful results have been obtained by means of moulding machines, both of which methods will now be described.

Hand Moulding.—The baths are moulded from sheet metal patterns, with a thickness of one-sixth to one-fifth of an inch of metal, according to the size and weight. The pattern must be thoroughly well hammered, to prevent bending and springing when the moulds are being rammed. A widespread error consists in attempting to obtain light castings by the use of thin metal patterns, because the moulders are then afraid to ram the moulds properly, the consequence being that the pattern works loose and the castings are irregular in weight, mostly coming out far too heavy. With sufficiently strong patterns, on the other hand, the fluctuations in weight can be prevented and accurate results obtained.

The mould is prepared in three-part boxes, which must be arranged in the simplest and handiest manner possible. The top and bottom boxes should be about 7 in. high, the height of the middle box varying with the depth of the bath. To facilitate assembling the moulds, the ends and sides are cast separately and bolted together. The bottom boxes are fitted with guides (preferably fish-plate guides), corresponding in length to the height of the core. The middle boxes, which fit in these guides, are provided with the snugs for the top boxes, and also with end trunnions for slinging. In order to afford

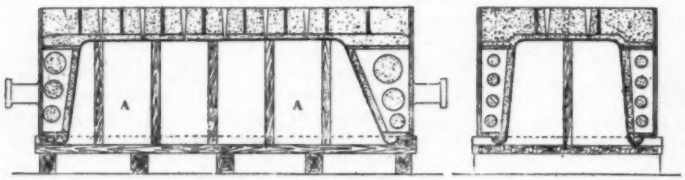

Fig. 1. Moulding the Middle & Upper Boxes.

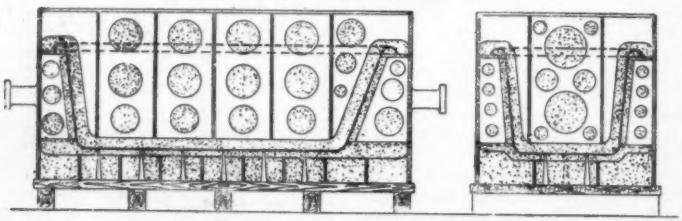

Fig. 2. Moulding the Bottom Box

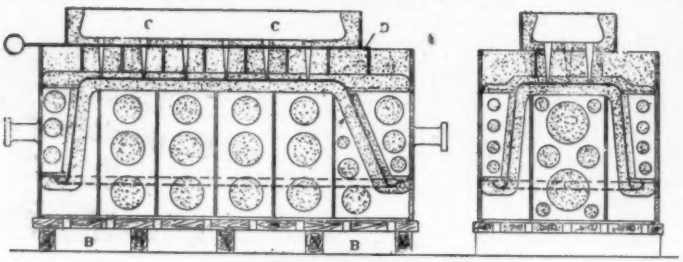

Fig. 3. Mould ready for Pouring.

a good hold for the moulding sand, traverses corresponding to the shape of the bath are bolted into the boxes, these traverses being perforated to allow unrestricted circulation for the gases and to diminish the dead weight.

A great point in moulding is uniform ramming; and the rammers must not came in contact with the pattern at any point, or a hole in the casting will result, the mould filling up immediately and keeping out the iron, so that the casting will have to be rejected. For the same reason the greatest care must be exercised in polishing the mould uniformly. The sand must be thoroughly pervious to air, and if the available sand be unsuitable it must be mixed with ground quartz sand.

The operation of moulding can be followed from the three sketches. The pattern and middle box are placed on a firm flooring (Fig. 1), the box being well rammed, and carefully polished on top. The upper box is then put in position and rammed, the gates being inserted at the same time. After covering the top with a smooth wooden cover and clamping the whole together, the mould is turned over and the ramming platform removed. The bottom of the middle box is polished, and the bottom box is put over it (Fig. 2), this being rammed and smoothed off. Vents are bored with a long rod, and a number of fluted longitudinal and cross air passages are made all over the box. A little sand is sifted over and the perforated pouring trough is worked into position, the whole being then clamped up again and turned. This latter operation must be effected quickly and without jolting, as many inexplicable waste castings are caused by jerky turning. The bottom boxes are generally without longitudinal traverses, and the cores are then liable to sink down under their own weight, leaving an air space between the core and the pattern. This produces unevenness in the walls of the bath, and an increased risk of cracking during the enamelling process. It is therefore desirable to provide two longitudinal traverses in the bottom box, an arrangement which divides up the weight of the heavy mass of sand and prevents shifting during turning. At the same time the

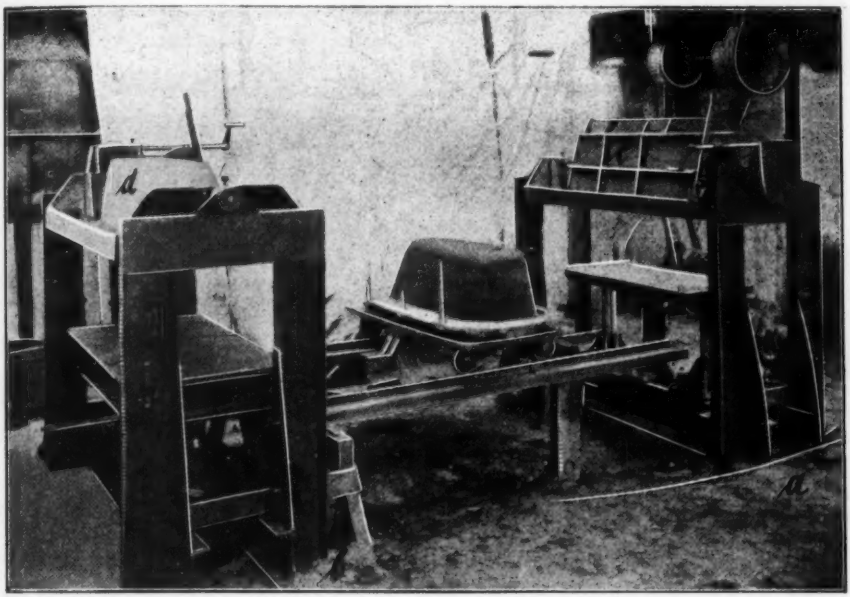

FIG. 4.—BATH-MOULDING MACHINE WITH TURNTABLES AND HYDRAULIC DETACHERS.

sand is more easily rammed between the pattern and the traverses; and as the sand is not required to hold in the compartments formed by the traverses, it has only to be filled in and trodden down. Of course, the layer round the pattern must be rammed properly. By this means a great saving of time is also effected.

After turning, the boxes are taken apart, the top one being removed first, and the pattern detached from the core after the middle box has been taken away. The mould is repaired and polished, the gates are pressed down with a knob, to prevent them breaking away later on, and the mould is put together again as shown in Fig. 3. The pouring trough is set in position, and the gates carefully finished off. As they occupy a large portion of the surface, provision must be made for efficient ventilation, this being effected (Fig. 3) by the insertion of long vent rods, which are drawn out when the mould is finished off. The pouring trough must be arranged with great care, and be large enough to hold all the molten iron required for casting the bath without overflowing when the metal is being poured. The metal is poured from two ladles, one at each end, these being emptied uniformly, the trough being supplied at such a rate that none of the gates can suck and thus give rise to porous places in the casting. As shown in Figs. 1 to 3, a number of small conical gates (about $\frac{1}{4}$ to $\frac{1}{2}$ in. across the bottom) are arranged over the bottom of the bath, this method giving light castings with walls of uniform thickness. If, however, this arrangement entails too much trouble, a couple of wedge-shaped gates may be used, though liable to give porous castings.

The iron for cast baths must be very hot and fluid; and an excessive content of graphite must be avoided, or the resulting baths will not take the enamel well, the coating being liable to spring off in the places where the graphite has separated out of the metal. The baths are finally fettled, preferably with an open sand blast.

The work of moulding is best performed by gangs, consisting of three or four labourers and a moulder, the former attending to the ramming and ordinary work, whilst the moulder sees to the finishing off of the mould. The outlay on wages depends on local conditions, but averages about 5s. to 6s. per bath. Owing to the large quantity of ramming to be done, the output can be considerably increased by the use of pneumatic rammers.

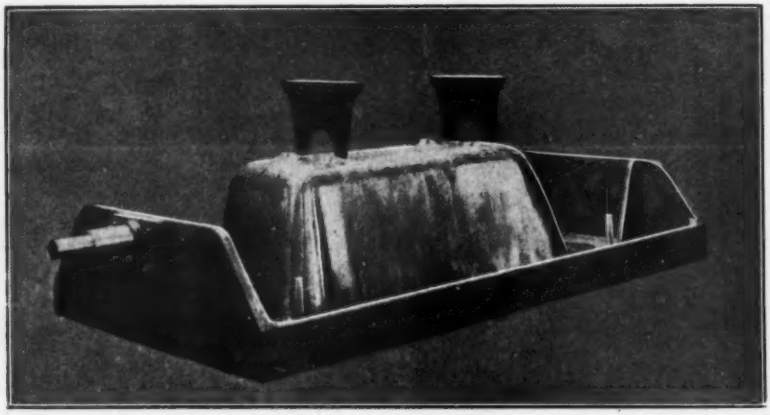

FIG. 5.—OUTER-MOULD PATTERN WITH WEDGE-SHAPED GATES.

Machine Moulding.—The use of moulding machines has proved advantageous in this branch of moulding also. In this system, only two-part boxes are used, a separate pattern being required for each box. The chief difficulty consists in the making of the patterns, the slightest inequality making itself unpleasantly apparent.

Fig. 4 shows a hand-operated moulding machine, with turntable and hydraulic detacher, as made for casting baths by the Alfred Gutman Aktiengesellschaft, of Ottensen, the idea underlying its construction being to imitate the method of hand moulding as closely as possible, whilst doubling the rate of output. As can be seen from the figures, a separate machine

is provided for each of the two boxes. The patterns are detachably mounted in the cranked turntables, so that the machines can be used for other purposes as well. The core mould, *c*, can be seen on the machine, *a*, and the outer mould, *d*, on the machine, *b*. The machines can be operated independently, and the method of working is the same as in other turntable machines. A finished core is shown in the middle between the sand and taken off again, whereupon the carriage is run over the press, which presses the sand into the core mould. The carriage is then lowered, and the finished core mould (shown on the left) is run out of the press.

The machine for the outer mould is of the pull-through type, the pattern, *e*, being placed on the plunger, *g*, by means of which it can be moved inside the frame, *f*, resting on the two cylinders, *h*,

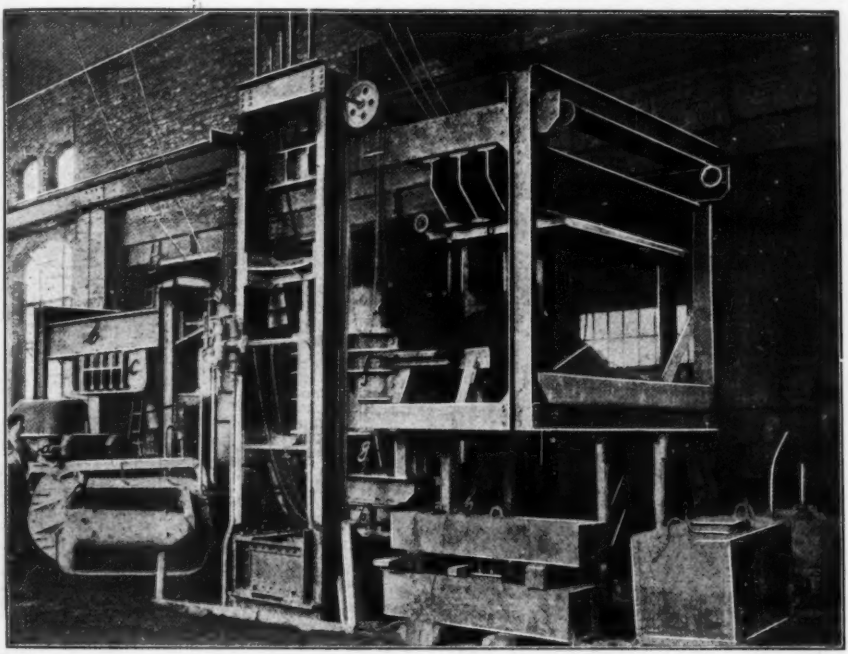

FIG. 6.—BATH-MOULDING MACHINE WITH HYDRAULIC PRESSES.

two machines. The outer mould, with the two gate funnels, is seen in Fig. 5.

A new type of moulding machine for cast-iron baths, is the hydraulic machine made by the Vereinigte-Schmirgel & Maschinenfabriken Hannover-Hainhalz (Fig. 6). This machine works without any turning of the boxes, the core-moulding machine on the left consisting of a press cylinder and plunger, over which travels the mould carriage, *a*. The core mould, *c*, is fastened to the fixed cross-head, *b*, of the press. In making the core, the bottom box is placed on the mould carriage, *a*, and covered with the wooden temporary mould, *d*, which is filled with the plungers of which are rigidly connected with the cross and side stays. The press head moves in guides arranged in the latter. In making the outer mould, the mould box is placed over the pattern, *e*, and is filled with sand, the press head *i*, being drawn forward and pressure applied to the two plungers, *h*, thus forcing the whole against the press beam. After relieving the pressure, the pattern is drawn through by means of the plunger, *g*. The top and bottom moulds are then fitted together and finished off for casting. Wedge-shaped gates are used, as can be seen from the finished bath on the left.

BRITISH FOUNDRYMEN'S ASSOCIATION.

Lancashire Branch.

THE fourth annual meeting was held on Saturday, October 3, at the Victoria Hotel, Manchester. There was a good attendance of members and friends.

The first business was the election of officers for the ensuing year, and the following appointments were made:—President: Mr. R. W. Kenyon (Accrington). Vice-President: Mr. G. Buchanan (Wrexham). Committee: Messrs. J. Kenyon, Markland, Mason, Penlington, W. H. Sherburn, Simkiss, Skelton, and Wright. Hon. Secretary: Mr. W. Sherburn (Warrington).

The President afterwards called upon MR. P. LONGMUIR (Carnegie Medallist), of Sheffield, to give his paper on "Alloys."

Alloys.

The lecturer defined an alloy as "a substance possessing the general physical properties of a metal, but consisting of two or more metals or of metals with non-metallic bodies in intimate mixture, solution, or combination with one another forming, when melted, a homogeneous fluid." The lecturer continued:—Examples of the union of a metal with a non-metallic body are found in the well-known carbon-iron alloys, and of the union of two or more metals in the various brasses and bronzes. An alloy may be formed by diffusion of one substance into another; thus, under certain conditions carbon will diffuse into solid iron and one metal may be made to pass into another. In some cases compression of the constituent metals when in a fine state of division will result in the formation of an alloy. However, in practice all foundry alloys are produced by fusion of the constituent metals. This may be expected in gas-, coal-, coke-, or oil-fired crucible furnaces, or in gas- or coal-fired reverberating furnaces. As a rule the coke-fired crucible furnace is employed for small quantities, and the coal-fired reverberating furnace for large quantities. Special mention should be made of the non-crucible oil melting furnaces, so well exemplified in the "Rockwell." Occasionally foundry alloys are products of the bottom or side-blown Bessemer converter, and of the open-hearth steel melting furnace.

Success in the production of alloys can only be attained by practical experience and personal contact with the difficulties encountered. There is no royal road, and very little guidance can be given on paper. Further, a distinction must be drawn between the production of laboratory and commercial alloys. Determining conditions, often ignored in the first case, have a very decisive bearing in the second one, in which the alloys have to meet competition and service conditions. In other words, a commercial alloy must not only yield its maximum properties, but must also be produced under conditions enabling it to compete with others on the market. To a limited extent some of these determining conditions have been noted by the author in an earlier paper read before the Association.

The metals which enter into the constitution of alloys are worth a few moments' consideration. Taking commercially pure metals, cast in sand and untreated, the following values have been obtained from tensile tests:—

Metals.	Mechanical properties.		
	Maximum stress—tons per sq. in	Elongation, per cent. on 2 inches.	Reduction of area per cent.
Annealed iron ...	20.0	40.0	60.0
R.H.H....Nickel ...	16.25	4.5	9.75
Aluminium	7 0	6.0	10 0
Chill ...Copper ...	10.0	25.0	26.0
Sand ..Copper ...	8.1	9.2	10.0
Tin	2.0	30.0	—
Lead ...	1.5	36.0	—
Zinc ...	1.5	—	—

These results are not particularly striking, and they emphasise the fact that commercially pure metals, cast in sand moulds, and untreated, are of comparatively little utility in the foundry. Of course, certain of the metals, such as copper, nickel, aluminium, lead, and zinc are used in a state of commercial purity for specific purposes; but the total weight of metals so made is not at all large. The properties of the metals undergo vast changes by working, such as forging, rolling, or drawing, and also by treatment, such as annealing, quenching, and the like. However, such processes are beyond the range of normal foundry practice. The object of alloying lies in a desire to modify the properties or the cost of the initial metals. The desired modification may be simply one of colour in the resulting alloy; on the other hand, it may be a change in mechanical, electrical, or chemical properties. In most cases the full modification may be obtained from the alloys in the cast condition; in other cases annealing

or other treatment may be necessary—a feature exemplified in the alloys of iron.

As a marked example of changes due to alloying, we may take that of electrical resistance. The resistivity of ordinary iron is 9.8 microhms per cc. If increasing contents of nickel are alloyed with this iron we have:—

	Microhms per c.c.
Iron	98
,, + 4.25 per cent. nickel...	29.1
,, + 4.95 ,, ,, ...	39.3
,, + 6.42 ,, ,, ...	42.8
,, + 19.9 ,, ,, ...	75.5
,, + 31.0 ,, ,, ...	86.5

These values represent the effect of one metal alloyed with another. If we take a triple alloy, say, iron + 14.5 per cent. Ni, + 5.0 per cent. Mn, the resistivity is 83—a value practically equal to that of 31 per cent. nickel-iron alloy. Incidentally this is also an illustration of the value of alloying in reducing production costs without impairing quality. Whilst on this subject one example may be taken from a Cu, Ni, Zn alloy. Thus, ordinary German silver gives a resistivity of about 21 microhms; the same German silver alloyed with 1 to 2 per cent. tungsten gives a resistivity of 41—nearly double that of the original alloy.

Another direction in which alloying is followed for its effect on physical properties lies in influencing solidification. As a rule, the solidification point of an alloy is lower than the mean of its constituents, and advantage is taken of this in the production of readily fusible metals. The opposite, in which an increase in solidification temperature occurs, is not so familiar, not yet much sought after. Yet this has a decided industrial value. Just one example may be given. Some of the steam-metal alloys contain a eutectic which solidifies at a comparatively low temperature. It therefore follows that on heating up from the cold this eutectic softens at a comparatively low temperature. Assuming the alloy to be in the form of a valve body, then on attaining a certain temperature this eutectic becomes pasty, and therefore porous. We have a solid valve body, containing areas porous to high-pressure steam. This is just the merest mention of a phase which has attracted attention in scientific circles. Long ago certain practical men discovered that the addition of a small amount of arsenic to steam-metal resulted in an alloy capable of giving better working life when exposed to heats somewhat above normal steam heat.

This addition of arsenic raises the temperature at which the eutectic softens, and therefore assists steam tightness at higher temperatures than would be possible in its absence. This is just one example of the value of raising a solidification point; no doubt many others will occur.

Alloying is also followed for its influence on chemical properties, chiefly in the direction of increasing the resistance offered to the solvent action of acids. Acid-resisting metals are chiefly remarkable for either a high content of lead or antimony. Cast irons are alloyed with silicon in order to achieve the same end.

Turning from the general to the particular, the most striking series of alloys are those known as steel. Ordinary steel castings are essentially alloys of iron and carbon, carbon being, as a rule, the only variable. The influence of this variable is as follows:—

Carbon.	Maximum stress.	Elongation.	Reduction in area.
Starting with pure iron 0.8	20.0	40.0	60.0
0.28	28.0	33.0	45.0
0.51	35.0	22.0	27.0

Good quality C.I. 0.5 per cent. c.c. 3.2 per cent. gr. 12 tons square inch, no elongation.

The three steels given represent surface-blown material, obtained in the usual way of commerce; the values given are high, and possibly somewhat above the average. However, it will be noted that a rise in carbon is followed by a rise in breaking load, and a fall in elongation and reduction of area.

Iron carbon alloys with a third element are for the most part familiar to forged steels. However, in the foundry special steels are at times produced, as exemplified in the production of certain types of shell, tramway points, crossings, and the like. No doubt the time will come when cast armour plate will compete with, and possibly replace, forged armour.

The following tests give results obtained from a series of nickel steels of almost constant carbon and manganese, but varying nickel. The steels were heated to 800 degrees C., and slowly cooled:—

	Ni.	Mn.	Elongation, per cent.
	Nil.	38 5	15.5
	1.2	43.2	14.2
	2.15	42.8	17.7
	4.25	43.5	13.1
	4.95	56.1	14.3
	6.42	57.5	6 2
	7.95	74.0	4.5
	12.22	71.2	6.2
Highest ...	15.98	76.5	4.0
Lowest ...	19.91	26.7	14.3

These results are possibly not of great industrial value; however, they give a

very good index of the influence of a third element. The addition of a third element does not always confer regular increases or decreases in properties. A good example of this occurs in the now well-known manganese steels. As Hadfield showed in 1888, gradual increments in manganese do not give regular increases in properties. Thus, up to 1 per cent. Mn, little effect follows. Beyond 1 per cent. brittleness is exhibited, and from 4 per cent. to 6 per cent. the alloy may be powdered under a hand hammer. At about 9 per cent. manganese, ductility returns, and at about 13 per cent. a material of entirely new properties is obtained. This manganese steel resists abrasion remarkably well, is almost unmachineable, and is toughened by dipping it at a full yellow heat into cold water.

Manganese steel forms possibly one of the best examples of alloying current in the metallurgy of steel castings. It embodies control of composition and after treatment. So far as steel castings are concerned the two features, composition and treatment, must be recognised. Investigation on these lines and from a purely foundry point of view will lead to considerable increase in our knowledge of steel alloys. An increase in knowledge often means the introduction of profitable work to the foundry.

In conclusion, Mr. Longmuir said: I have only touched on a very small portion of an exceedingly large field. My object has been simply that of—as I hope—raising discussion. The subject of alloys is one which certainly admits of very wide discussion. With all our investigations and study—and after all our experience comparatively little is known—much has yet to be learned.

Discussion.

After the discussion on "Alloys," a question as to the merits of a receiver to a cupola for light and medium castings came up for discussion. The experience of various members—some extending over 20 years' use of a receiver—were given. The general verdict was that while the receiver gave some advantage in the direction of a clean and uniform mixture of the molten iron, this did not justify the extra cost of running and maintenance, and the risk of accident which undoubtedly accompanies its use.

The Annual Dinner.

A large company sat down to dinner at the Victoria Hotel at the conclusion of business. The President, Mr. R. W. Kenyon, was in the chair.

Mr. W. Russell, in proposing the principal toast, "The Lancashire Branch of the British Foundrymen's Association," recalled the circumstances of the formation of the Branch, which resulted from the meeting of a few individuals in Manchester, about four years ago, and its rapid growth since.

The President, in responding, said the desire of the Council was that the Association should command the attention of the foundry trade more generally throughout the kingdom than it did at present. It might be admitted that whilst in some of the larger establishments the scientific side of foundry work had received attention, there was perhaps more rule-of-thumb than scientific method in general use in this country. An effort should be made to secure as members, at a lower scale of fees, students and apprentices; for educated labour would always secure better results than uneducated. (Hear, hear.) The man who worked not as an automaton, or a machine, but with a knowledge of the inside of his subject, had greater interest in his work and got more enjoyment out of it, whilst at the same time he produced better work than the uneducated man. It would be useful if members of the Association who had problems to face would state them in writing; they might be submitted to some competent authority for solution, or be made the subject of debate at one of their meetings. There were a few subjects he would like to hear more about. One was with respect to the casting temperature. As was conclusively shown, in a lecture last session, there was a definite temperature which would produce the strongest casting, and that not a very large variation above or below this temperature would reduce the strength of the casting almost abnormally. Admitting the truth of this there was still the problem—How was it possible, commercially, to adopt a standard? How was it commercially possible to ascertain the temperature of every shank on ladle and metal, and, assuming that that was attainable, how was all the metal to be kept up to the requisite temperature? Also, what was to be done with that which fell below the proper temperature? There were other problems also, such as casting bosses on their castings without having drawing or sinking—the question of scientifically mixing irons to suit various classes of work; also the question of the best way of transporting metal to the furthest end of a long foundry where the castings are very light and require very hot metal. There were hundreds of small foundries whose profits were too much minimised to

allow of the employment of an expert; and a useful work would be performed if it could be shown how, by tests as to strength, as to fracture and as to shrinkage, or in any other way, they could get a reliable standard by which to determine the merits of various brands of pig-iron. (Hear, hear.) There was also a good deal to be said regarding blast pressure, and also on the question of blower *versus* fan; and, for those interested in the cheap production of a large quantity of small castings, information regarding the relative advantages of hydraulic and pneumatic moulding machines, as compared with the ordinary hand-rammed machine.

The health of the retiring President was proposed from the chair and responded to by Mr. Sherburn.

Mr. Mason gave the toast of "The Visitors."

Mr. Longmuir responded. Speaking of technical training in connection with foundry work, he said the Council were specially desirous to encourage the growth of a school of foundry thought. (Hear, hear.) That school of thought must proceed from the foundation. They must have foundrymen who took an interest in the progress of their craft. Any day spent in a foundry revealed a multitude of things requiring investigation. Work in that direction had its own reward, apart from any financial gain that might attend it. (Hear, hear.)

BIRMINGHAM BRANCH.

There was a large attendance of the Birmingham Branch of the British Foundrymen's Association at the Technical School, Suffolk Street, on Saturday, October 24, to listen to the Presidential address of Mr. R. Buchanan.

The Hon. Secretary, Mr. C. Heggie, presenting the balance-sheet for the year, said the income from subscriptions, which was their only source of revenue, amounted to £11 17s., and this, with a balance from 1906-7, of £2 4s. 11d., totalled £14 1s. 11d. Expenditure had amounted to £12 1s. 9½d., and there was cash in hand to the extent of £2 0s. 1½d.

Mr. R. Mason, who presided, briefly introduced the President, remarking that they were always pleased to have him with them.

Presidential Address.

The President congratulated the Secretary on including in their syllabus lectures from such distinguished metallurgists as Professor Turner, Mr. A. H. Hiorns, and Mr. J. H. Stansbie, whose continued interest and great kindness they all greatly appreciated. He continued:—

From certain remarks which I recently heard it may be well for me to re-state, very shortly, what I conceive to be the function and aim of the British Foundrymen's Association.

Many of us thought that we in this country who are engaged in foundry work were not moving along lines of advance which were open to us. I have always maintained, as I maintain now, that our operative foundrymen are second to none in the world. That does not mean that in operative work we have nothing to learn from anyone. To say so would not only be foolish but also untrue.

Only by recognition of the fact that there is no finality, either on the operative or scientific side of our industry, is it possible to have the zest and enthusiasm necessary for advance. Where there is finality, advance is impossible. Wherever one finds a person who professes to know all that there is to be known about a subject, either the subject is a trifling one or the person deceives himself. Such a belief, if truly held, is a measure of ignorance, not of knowledge. Thus it is that we of the British Foundrymen's Association have come to school again; some are in the lower forms, and some have moved up a class or two, but we are all scholars attending a great school of knowledge. It cannot be too much emphasised that with the monetary relationship of employer and employed, or the differing merits, or the reverse, of Unionism or non-Unionism, we have nothing to do. We meet to hear papers read and discussed, so that we may be more efficient workmen, foremen, and managers, and, therefore, better and more profitable citizens.

Complaint has been made that many of our papers are too severely scientific, and not "practical" enough. A scientific observation, or, more correctly, a physical fact or law which has been proved by the application of science to exist, may or may not be immediately applicable to practical work; but no man, however wise he be, is in a position to judge rightly whether these facts or laws may not be, under certain conditions, of the most practical use. This use of a fact or law may be early or it may be late, and it may not be the good fortune

of the discoverer or the exponent so to apply it. This may be, and often is, the work of another who can recognise the fact or law, and bring into practical use what seemed to have only a distant relationship to practical things. Thus it is that, however apparently trifling an observed fact may be, no limit can be placed upon the possibilities which may follow. I have heard it said that a man devoid of imagination cannot be a good mathematician. To this I would add that neither can science be applied to practical work if the imaginative sense be absent. By inductive reasoning and the use of known laws one can build up in the mind the probable results which will follow the application of these laws to practical work. It is only a truism to say that all practical work is done through the application of science and scientific method. We may not recognise, and may not even know, the laws governing the methods and materials we are using. These laws exist whether we know it or not, and the successful worker is he who most works in agreement with them. As it is not possible to do good practical work and yet transgress scientific, that is, natural, law, the more we know about these laws, their presence, and the means by which they may be applied, then the better practical workers we shall be.

It is undoubtedly the case that most folks like the results of laws or principles rather than the laws or principles themselves. It saves them a great deal of trouble; but even now there is no royal road to learning. There is quite a large amount of bad science spoken and written, and unless one is in a position to discriminate betwixt the true and the false, trouble is apt to follow the use of "ready-made" scientific panaceas.

There are two clearly-defined attitudes regarding science for the foundry. One is that it is of little value, and that the old methods are good enough. The other is a child-like acceptance of anything which claims to be scientific. With the former class I shall not now deal. The latter class has something pathetic in its attitude of mind. The eagerness for scientific fact, or what passes for such, makes them as uncritical as were the people of the Middle Ages regarding theology. What is required is a more critical frame of mind, and criticism founded on knowledge. Even criticism founded on ignorance is better than a blind acceptance of what may or may not be a scientific fact. There is said to have been at the Papal Court an official called the "Devil's Advocate." His function was to show cause why certain deceased persons should not be canonised as saints, and so keep the saints from becoming too great in number. So he brought forward all the derogatory things he could ascertain regarding the particular personages. Thus it was that Sir Snow Harris, President of the Royal Society in Faraday's time, played the part of "Devil's Advocate." When Faraday enunciated some of his daring theories—theories founded on knowledge regarding electrified bodies—Sir Snow Harris denied that it could be so. Faraday was compelled to prove the correctness of the theory, and as a result we have the dynamo and other great advances in electrical and magnetic science. I have heard it said that a popular treatment of science is not possible; that if it was popular it would not be science, and if it was science it would not be popular. That appears a somewhat awkward dilemma for the writer who would write about science in such a way as to be generally understood. The fearful and wonderful "scientific" articles one sees in certain monthly magazines make the patience of the British people a matter of wonderment. Of what earthly value is it to know that the water contained in a certain number of tons of potatoes will suffice to float an ironclad, or some similarly absurd statement. Such stuff may be popular, but it is certainly not science. Meanwhile, the public scan these so-called "popular science" articles with a comfortable feeling that they are acquiring scientific knowledge with a minimum of trouble. The amount of science so acquired is exactly measured by the amount of trouble taken; that is, it is practically non-existent.

We come now to a consideration of the question as to whether the actual practical work of a foundry can be taught by means of books. I do not say that it has been so claimed, but perhaps the subject is worth discussion. In this connection, my own opinion is that the principles underlying practical work may be so taught, but not the practical work itself, unless it be the most elementary facts. Books and articles on founding are written and read as if the processes could be described, and, when described, understood. I sometimes read articles describing ways of moulding certain castings, and if I did not already know how to mould them, the description would be as illuminative as so much Greek. I am not blaming the writers;

only they have been trying to describe the indescribable. If one knows the way to make the particular casting, a description of how to do it is a work of supererogation. If one does not know how to make the casting, no amount of written description will inform the tyro how to do it. The only occasion on which such description of practical operations is of any value is when an improved method is described by a practical man, and such improved method is read and put into practice by one already versed in the art.

If one were to write a really full description of, say, the moulding of a cylinder, and go on to describe everything done from the receipt of the pattern to the taking out of the finished casting, such a description would not only be interminable, but would be so insufferably dull that no one would read it. That would be a fortunate escape for the would-be reader, because if he did read the description he would not understand it. Can anyone describe in writing the varying softness or firmness with which the different parts of a mould should be rammed? Or can one describe the particular condition of dampness the sand should be in for the particular casting about to be made? Or the right condition of heat of the metal when pouring should begin, and the varying rapidity with which the mould should be filled? These are a few of the many important operations which must be definitely known if successful work is to be done, and each of them is impossible of description by pen. The only place to learn how to do practical foundry work is in the foundry. The principles underlying foundry work and foundry operations may be learned from books and from papers, but the actual operations themselves cannot be so learned.

However deficient may have been the education a boy has had when he comes to serve his apprenticeship, he once more gets a chance to, in some measure, make up for the loss he sustained. In this connection I propose reading to you some words written by Hugh Miller about the middle of last century. Miller was a working mason, who gained an honourable place as a geologist, journalist, and author. In his book, "My Schools and Schoolmasters,"—one of his schools being the seashore and some of his schoolmasters being his fellow workmen—he says:—

"The destiny in life of the skilled mechanic is much more influenced, for instance, by his second education—that of his apprenticeship—than by his first—that of the school; and yet it is to the education of the school that the importance is generally regarded as attaching, and we never hear of the other. The careless, incompetent scholar has many opportunities of recovering himself; the careless, incompetent apprentice, who either fails to serve out his regular time, or who, though he fulfils his term, is discharged an inferior workman, has very few; and, further, nothing can be more certain than that inferiority as a workman bears much more disastrously on the condition of the mechanic than inferiority as a scholar. Unable to maintain his place among brother journeymen, or to render himself worthy of the average wages of his craft, the ill-taught mechanic falls out of regular employment, subsists precariously for a time on occasional jobs, and either, forming idle habits, becomes a vagabond tramper, or, getting into the toils of some rapacious task-master, becomes an enslaved sweater. For one workman injured by neglect of his school education, there are scores ruined by neglect of their apprenticeship education."

The speaker proceeded to express regret that the squabble over the conditions under which education should be imparted had distracted attention from the all-important subject of education itself, while the Universities had generally become the possession of the upper and middle classes. The university should be the Mecca towards which the eyes of all scholars should be turned, let the origin of the scholar be ever so lowly. That could only be attained by a system of small bursaries and scholarships such as existed in connection with the Scottish Universities. Knowledge led to sanity of behaviour, patience in adversity, humility in success, love of work for work's sake, sacrifice for, and devotion to, our common country.

The speaker next referred to the work of the National Physical Laboratory with a view of showing how it could help the ironfounding industry, and probably others as well.

He continued:—All foundrymen are aware of the losses which take place in every foundry through what Longmuir terms "liquid contraction." I think I am well within the mark when I say that in Britain alone the annual loss from this cause alone cannot be less than a quarter of a million pounds. Some of us who have paid attention to this difficulty; some as scientists and others as practical founders, have got to understand

some of the conditions by which "liquid contraction" may be minimised, if not quite obviated. That is about all that can be said regarding our present knowledge and practice. What is wanted is a complete investigation of the conditions under which "liquid contraction" takes place, and this investigation to be a preliminary to finding, if possible, means to eliminate this source of loss.

It will not be possible to confine this investigation to the laboratory. Only by the co-operation of the metallurgist and the foundryman can any advance in knowledge be made. The cases where "liquid contraction" takes place show themselves only in a minor degree in the metallurgical laboratory. The trouble arises in the foundry working under commercial conditions, and there these same commercial conditions preclude the foundryman from investigating the phenomena, even were he endowed with the scientific knowledge necessary. The subject, then, is one which must be investigated by the scientist in the foundries of the country, and with the help and co-operation of the founders.

If the National Physical Laboratory takes up this work—and being "National" I think we have some claim upon its services—I venture to promise on behalf of ironfounders ample opportunity of investigation, and, so far as in us lies, our help. Such an investigation would not only be of the greatest possible interest from a scientific standpoint, but should also be of great benefit monetarily to those engaged in the industry. There is the further advantage that such an investigation comes into conflict with no vested interest, either professional or practical.

The speaker proceeded to quote figures showing that the wood supplies of the world are being rapidly exhausted, and that thirty years hence there will be great scarcity. The effect of this will be to lead to a more extensive use of iron and steel, and will affect the pattern-makers in particular, very considerably, and through them the foundries. On this he remarked:—

So far as foundries and the skilled men who work in foundries are concerned, it behoves us to prepare for a condition of matters which has every appearance of coming to pass. It has to be confessed that foundrymen, as a rule, are very deficient in the capacity to draw in freehand or to read machine drawings. During all my career, I have met only a few foundrymen who were at all facile in either respect. This subject of freehand and mechanical drawing is one to which foundrymen might well give increased attention. I say increased attention, but it must be admitted that it is getting practically no attention whatever at the present time. I believe I have mentioned before that Mr. J. W. Hall, of Birmingham, has told me that at a foundry in Belgium he saw the moulders making moulds for engine castings direct from the drawing, without the interposition of the pattern-maker in any respect whatever. He also saw some of the castings, some of them very difficult, made in this way, and they were satisfactory in every respect. That they were cheaply made is apparent from the fact that this foundry was making castings for German engineers, sending them across the frontier, with heavy tariffs to pay. As Mr. Hall has himself been engaged in foundry work, there is no reason to doubt the accuracy of his observation. I am aware, as also most of you are, that in this country propellers and other castings are made without patterns, only a few sweeps being used, but I am certain that with a more highly developed skill to read drawings, the British moulder would be competent to do anything the Belgian moulder can do.

In actual practical foundry work, as you have often heard me say, the British moulder has little to learn from anyone. If it were otherwise, British engineering would not be in the commanding position it is in to-day. The various problems, such as the cylinder engine with low-pressure steam, the compound engine with high-pressure steam, and the turbine, which the engineer has set him, he has solved successfully. The extension of the system of making castings without patterns may be forced upon us as a measure of economy made necessary by the shortage of timber, to which I have referred, or by a desire to eliminate the pattern-maker and the pattern, but whether such a method of work be adopted or not, I think you will agree that the capacity to do work in this way may well engage the attention of young men now learning the art of founding.

Referring to the condition of trade and employment, the speaker expressed his belief that trade was now turning the corner and moving towards better trade and better employment.

In concluding this address, I now refer to a matter which we may consider to be of a domestic character, and relates to ourselves and possibly to some others. A

journalistic friend of mine, one with a very extended experience of public meetings and public speakers, said to me recently, in a tone of chastened sorrow, that readers of technical papers, of which they were the authors, commonly spoke too fast, and were often inaudible. They spoke most rapidly when most technical, and the speakers after the reading of the paper were often rather worse. That is strong criticism, but given for our good so that we may amend our ways. If I thought that my reference to this would dishearten readers and speakers I would not refer to it, as bad reading and indifferent speaking are infinitely to be preferred to silence, unless absolute nonsense is being read and spoken. Carlyle's saying, that "speech is silvern and silence golden," would not suit a technical society like this, and, indeed, a large number of our members preserve more fully than they ought that "golden silence."

I do not presume to instruct you in this matter. Plainness and lucidity of speech, whether written or spoken, are only to be got by practice. Let us practice the speech, not the silences, however illuminating the latter may sometimes be. Let us remember for our comfort that Benjamin Disraeli and many another broke down in his first speech. If models for writing and speech are sought, they are to be found amidst the abounding treasures of our English literature.

The CHAIRMAN said that the address had been extremely interesting, and judging from the large gathering it had drawn together, he thought they might look forward to a very interesting session.

MR. A. H. HIORNS remarked that he was very much interested in the large number of subjects dealt with in the address. That was the kind of inaugural address suited to a Society like theirs. The drier matters would follow later in the papers. The President had referred to a complaint that many of the papers were too technical to be understood by the members. Their trade was technical, and if they did not use technical terms they would have nothing at all to say with regard to the application of science to practical work. A great many persons considered that there was very little connection between the two. But the man who thought he was quite good enough workman without scientific knowledge was the one who had a considerable amount to learn. Every advance in this country had been due to previous scientific investigation. There was no invention or discovery that came spontaneously to the inventor or the discoverer. They might read about such-and-such a man who had invented a certain thing, but if they read up the subject they would find that a great number of others had dealt with the same thing, though probably not to quite the same extent. With regard to scientific research, they were all well acquainted with the admirable work done a few years ago by Professor Turner in connection with the effect of silicon on cast iron. He did not suppose Professor Turner had any idea at first of what use that would be to foundrymen in general. Mr. Buchanan had said that science was never popular, and if it were popular it would not be science. Science was very popular with anyone educated to appreciate it. The more they knew of science the more entrancing it became, and the more they wanted to learn. He had been impressed many times in the course of his career by meeting men who were totally uneducated apparently without scientific knowledge, yet skilled workmen. He contended, however, that such men had scientific knowledge though they didn't know it, and were working in a scientific way. If work was not done in a scientific way it became troublesome, and many wasters were made. But there was one great difference between a man who had, and a man who had not, received scientific training. The skilled workman lacking scientific knowledge might work for thirty or forty years, and in the course of time discover certain things; but whereas it would take him years to determine the reason for these things, the man with scientific training would be able to discover the reason in a few hours. The great fault in the elementary and higher education was that the scholars were not taught to think for themselves; the teachers did all the thinking for them. He had always been greatly impressed by the facilities afforded by the Scottish Universities for working boys and youths to get a university training. With regard to university training, they could not expect to be taught a trade at a university. How could they expect a university to teach such trades as casting, pattern-making, ironfounding, baking, drapery, shipbuilding, paper-making, etc., as well as making politicians and journalists. It could not possibly be done! Some universities, for example, were endeavouring to teach moulding, and employed a furnace (he did not think they had a cupola). At the very best it was only just "pottering" with the subject. A university could not deal with the number of operations carried on at the works. They had at the Technical School a few lathes and drilling machines. But these were very few when

compared with the equipment of a modern engineering workshop. When a man went into a workshop he found that he had to deal with matters in a very different manner. There was a great opening for a central laboratory. He did not know that the National Physical Laboratory could do a hundredth part of the work required, but certainly there might be some sort of laboratory in Birmingham. There were numbers of small works in the district which could not support a metallurgical chemist. With the aid of such a laboratory solutions might be found of many of the curious phenomena which constantly presented themselves in practice. For instance, he had himself met with a very singular experience. A casting had been made with a certain brand of iron, yet if one pig of another brand of equal quality, and apparently exactly the same in all respects, was added to a mass of the first there would be a distinct difference in the result. This difference was extremely difficult of explanation. Mr. Hiorns concluded by proposing a hearty vote of thanks to the President for his address.

Mr. F. J. Cook, President of the National Association, seconded the vote of thanks. Speaking of education and apprenticeship, he said that the question was one of the things that would have to be tackled by any society which dealt with any particular trade. The apprenticeship system seemed to be dying out; at any rate, the education of young men in a particular trade was a very important question, and one which must be kept in view if they had the welfare of their trade at heart.

The Chairman remarked that it would be an excellent thing if a laboratory were established in Birmingham. There was undoubtedly great need of it, and some day it would have to be done.

The vote of thanks was heartily agreed to.

Mr. Buchanan, thanking the members for the vote, said the question of liquid contraction was one of great magnitude, and only by such action as he suggested on the part of the National Physical Laboratory could it be solved. He had been thinking about it and observing it closely for a number of years, and asking questions of his friends which they confessed they could not answer. Neither could he. Foundrymen in charge of foundries, men with experience, would all say that what they knew about liquid contraction was very little indeed. They required action by persons of high scientific attainments in conjunction with men of foundry experience. It was a matter affecting the success of our industries to the highest degree; possibly in this country there was a loss of a quarter of a million castings every year from liquid contraction alone. The number might be more, it might be less, but the annual loss certainly ran into thousands of pounds. Foundrymen knew all about it, except how to prevent it, and combined action with the scientists in the laboratory was the only hope for elucidation of the mystery, if elucidation were at all possible.

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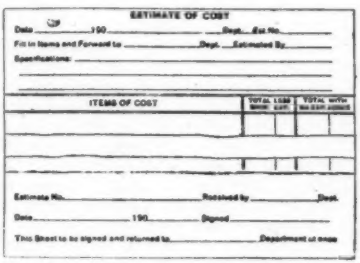
ESTIMATING IN THE FOUNDRY.

A simple system for estimating, checking by actual costs, and filing for convenient reference was recently contributed to the "Iron Age." The writer outlined a plan that is now in use with satisfactory results, and suggested that with some


ESTIMATE OF COST

Date _____ 190_____ Dept. _____ Est No. _____

For in items and Forward to _____ Dept. _____ Estimated By _____

Specifications: _____

ITEMS OF COST	TOTAL LESS MACH. EXP.	TOTAL WITH MACH. EXP. ADDED

Estimate No. _____ Received by _____ Dept.

Date _____ 190_____ Signed _____

This Sheet to be signed and returned to _____ Department at once

Fig. 1—Form No. 1, Foundry Estimate Sheet.

changes it might meet the conditions in other shops. The details of the system and the forms employed are given herewith:—

When a request from a customer for a quotation for some particular job is received the cost department issues on the foundry an application for an estimate to be submitted in accordance with specifications. The foundry estimate is then made out, giving the required details on Form 1, the original being sent to the cost department and a carbon copy retained and filed, together with all data made out for the benefit of the foundry department. When the estimate is submitted the portion at the bottom of the sheet is signed and returned to the foundry as a receipt.

If the order for these castings is received, a shop order bearing the estimate number and all necessary information is issued on the foundry. It is very im-

portant that the estimate number be given, so that it will be readily recognised as an estimated job, otherwise it might be easily overlooked.

As these shop orders are issued in duplicate, a copy is sent to the pattern storage, where duplicate tags are attached to the pattern and the job set aside ready for the sand. When put in the sand the moulder retains one tag, and the duplicate, on which is marked the date and floor number, is immediately handed over to the foundry cost clerk. Form 2 is immediately filled out and the time put on the job. This sheet, on which is entered the estimated costs and weights, is good for four weeks' work, and when the job is completed the actual costs and weights are readily compared. After the first few castings are made the cost is figured as a check on the work.

In order to dispose of an undesirable accumulation of time cards, Form 2 has been introduced, and has been found to be far more satisfactory. All records are contained on one sheet. If the time necessary to complete the job is more than four weeks, two, or even three sheets can be used, as the case may require.

Besides being used for costs on estimated work, these sheets are of equal value in obtaining costs of new patterns and regular work, etc. To be brief, the form was drawn up so as to be as near universal in its application as possible, and is one that might be applied to advantage on general jobbing work. As the estimates are not received in numerical order it is necessary to remove the carbon copies from the book provided and file in some accessible form. The usual vertical filing system seems very well adapted to this work and affords a very convenient method of quickly locating the desired estimates, the estimates being filed numerically.

When making up an estimate it is well to look up the cost sheets, Form 2, of past records on a similar class of work. These costs will show whether previous estimates have been high or low, and will greatly assist in estimating more closely and with greater accuracy than could possibly be the case if the foundry had no reliable data.

To locate readily a number of estimates under some particular class of castings, proper indexing is necessary. Several

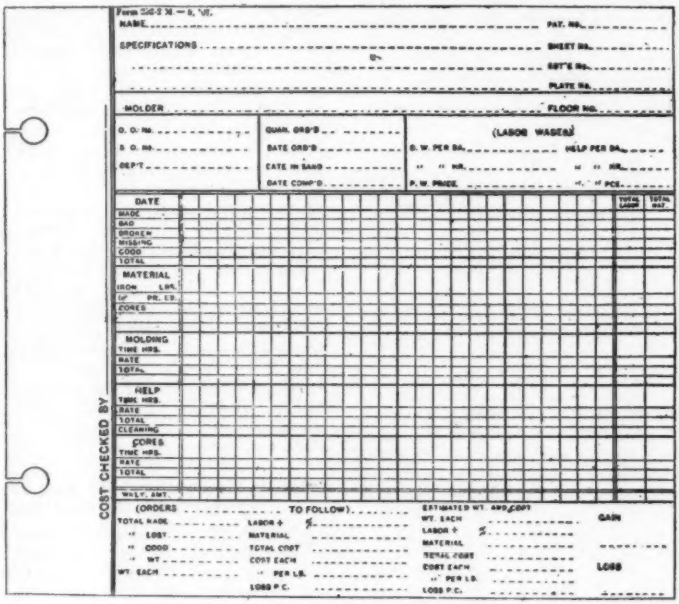


FIG. 2.—FORM NO. 1, COST SHEET.

methods will be found available, any one of which may be applied. The first guide card in the drawer of a vertical filing cabinet is marked "Index," and one of the cards is shown in Fig. 3. The class of castings is entered at the head of the column and the estimate numbers are placed in the columns under their respective headings, thus making it very convenient to locate several estimates, with their costs, on any particular class of work previously recorded.

The plan as outlined above has been executed with as little labour as possible in an effort to obtain the most reliable information, and the results in many cases are surprising. The knowledge

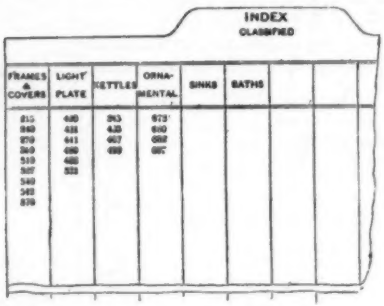


FIG. 3.—INDEX CARD.

gained in carefully operating such a system is of great value, and will soon enable one to overcome the small expense of compiling such data, to say nothing of the satisfaction and confidence that may be experienced.

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REGULATIONS FOR THE CASTING OF BRASS.—The Form of Notice prescribed by the Secretary of State for use where exemption from the Regulations is claimed in respect of a sand-casting shop, has just been issued, price one penny (by post 1½d.).

MR. J. GRANT, who, some time back was connected with Cammell, Laird & Company, Limited, has joined Mr. G. R. Hall, ironfounder, Newgate Works, Worksop, and in future the business will be carried on as Grant & Hall. We understand that the Company propose adding the manufacture of crucible steel castings, etc., to the present business.

SULPHUR AND IRON.

A CROWDED meeting of the South Staffordshire Iron and Steel Institute on Saturday, October 17, met at Dudley to hear a paper by Mr. J. E. Stead, F.R.S., of Middlesbrough, on "Sulphur and Iron." This was the second contributed on the same subject, and both the paper and the discussion dealt mainly with cast-iron. Mr. Stead also exhibited his new microscope with various samples of pig-iron.

The paper mainly called attention to some important research carried out by Mr. Donald M. Levy, assistant lecturer and demonstrator in metallurgy at the Birmingham University. Mr. Levy, the lecturer remarked, had added much to their knowledge. He had endeavoured to explain how it was that the presence of sulphur in cast-iron tended to prevent the separation of the graphite, and his hypothesis, although not conclusive, was very welcome, as it had always been an obscure point to metallurgists how it was that sulphur had such an effect. Mr. Levy had stated that the effect of sulphur on the strength of cast-irons free from silicon and manganese was not very great, and the sulphides did little more than emphasise the hardness, brittleness, and weakness of the irons. But Mr. Levy's research was confined to alloys free from manganese and silicon, and the effect of sulphur might be more or less modified when these elements were present.

Relative Harmfulness of Sulphur-Bearing Minerals in Iron Ores.

Continuing, MR. STEAD said:—

Since my last lecture further attention has been paid to the determination of the relative harmfulness of different sulphur-bearing minerals in iron ores, and many experiments have been made in my laboratory with iron ores, mixed iron pyrites, sulphates of lime, and sulphate of baryta respectively, and then smelted in crucibles. As the results obtained are of a somewhat important character, it will be necessary to describe rather fully the method employed in making this research.

The difficulty of making independent smelting operations under identical conditions being exceedingly great, in fact almost impossible, the very simple device was adopted of smelting the several mixtures in large plumbago crucibles divided into sections, so that comparative smeltings could be done at the same

time, and under the same conditions of temperature and time. In preparing the crucibles, excepting the first trial in which coke dust was used for the lining, charcoal powder was mixed with starch paste, made into a plastic mass. This mixture was rammed into the crucibles round and between tubes 1 in. in diameter, which were placed vertically in the crucible. These tubes were then drawn, leaving corresponding pockets or cavities. The crucibles prepared in this way were carefully dried, and into the pockets the various mixtures were placed, and after covering with charcoal, and plumbago lids, they were heated for an hour at about 900 degrees C., and finally for half an hour to near whiteness.

Analyses of Materials.

The ores used were Bilbao rubio ore and Dunderland magnetic iron concentrate, the analyses of which are as follows, viz. :—

	Rubio. Per cent.	Dunderland. Per cent.
Iron ...	54.25	69.30
Silica ...	10.15	2.45
Manganese ...	0.60	trace
Sulphur ...	0.02	0.01

Sulphur-bearing minerals	Per cent sulphur.
Iron pyrites	42.0
Calcium sulphate	23.6
Barium	13.6

SERIES I.

	Grms.	Grms.	Grms.
Rubio ore ...	20	20	20
Pyrites	0.47	—	—
Calcium sulphate	—	0.85	—
Barium sulphate	—	—	1.45
Fluorspar ...	4	4	4

The sulphur in the weight of the several minerals used in these experiments was equivalent to 1 per cent. on the ore.

Metal Produced.

	Ore+Fe_2S Per cent.	Ore+$CaSo_4$ Per cent.	Ore+$BaSO_4$ Per cent.
Sulphur ...	0.68	0.55	0.67
Silicon ...	1.86	2.03	1.82
Relative harmfulness of sulphur-bearing mineral, taking the pyrites as 100	100	81	98

The fluorspar was used to flux the silica. All the slags were of a greenish yellow tint. In this Series the crucible was lined with coke dust containing about 1 per cent. sulphur, and some of this sulphur may have passed into the metal. The results, notwithstanding this, are of comparative value. All the subsequent trials were made in charcoal-lined crucibles.

SERIES II.

Crucible lined with charcoal. Mixtures and treatment the same as in Series I.

Analyses of Metals.

	Ore+Fe_2S Per cent.	Ore+$CaSO_4$ Per cent.	Ore+$BaSO_4$ Per cent.
Sulphur ...	0.473	0.315	0.336
Silicon	0.720	0.630	0.610
Ratio of sulphur present	100	87	84

SERIES III.

The same as Series II., excepting that the sulphur-bearing minerals were diffused through the powdered mixtures in small lumps from 2 to 3 mm. in diameter, instead of a fine powder, and the smelting temperature was not so high.

Analyses of Metals.

	Ore+Fe_2S Per cent.	Ore+$CaSO_4$ Per cent.	Ore+$BaSO_4$ Per cent.
Sulphur ...	0.665	0.770	0.686
Silicon ...	0.163	0.280	0.117
Ratio of sulphur present ...	100	117	103

SERIES IV.

Twenty grms. Dunderland magnetic ore, 2 grms. of charcoal, and 1 grm. fluorspar were used in each experiment. The same amounts of sulphur-bearing minerals as in the previous Series was added.

Analyses of Metals.

	Ore+Fe_2S Per cent.	Ore+$CaSO_4$ Per cent.	Ore+$BaSO_4$ Per cent.
Sulphur ...	0.720	0.651	0.590
Silicon ...	0.840	1.050	0.770
Ratio of sulphur present ...	100	90	80

Metals were all white. Slags were all grey.

SERIES V.

The same mixture as in Series IV., but the 1 grm. of fluorspar was replaced by a previously formed slag or flux containing about 50 per cent. lime, 38 per cent. silica, and 12 per cent. alumina. The object of this trial was to imitate as near as possible blast-furnace conditions. The coke fire got choked at one side and the crucible was not uniformly heated; the side containing the barium-sulphate got very hot indeed. The results are not, therefore, strictly comparative.

Analyses of Metals.

Reference Nos.	18 Ore+Fe_2S Per cent.	19 Ore+$CaSO_4$ Per cent.	20 Ore+$BaSO_4$ Per cent.
Sulphur ...	0.178	0.178	0.006
Silicon ...	0.513	1.097	0.607
Ratio of sulphur	100	100	4

All the metals were white excepting No. 20, which was very grey. The slags were all grey.

SERIES V. (A).

This was a repeat trial of No. V. Series, but the heat was again uneven, the side of the crucible containing the pyrites being the lowest in temperature.

Analyses of Metals.

Reference Nos.	26 Ore+Fe_2S Per cent.	27 Ore+$CaSO_4$ Per cent.	28 Ore+$BaSO_4$ Per cent.
Sulphur ...	0.329	0.205	0.178
Silicon ...	0.100	0.650	0 583
Ratio of sulphur	100	62	54

All the metals and slags were grey The results of the Series V. are put in as showing how difficult it is to get strictly comparative results. In reviewing the work and averaging the results it will be seen that the average of No. 1 $BaSO_4$ Series indicates that 1 per cent. of sulphur in the ore in the state of Fe_2—$CaSO_4$ and $BaSO_4$ leaves sulphur in the pig in the following proportions :—

	Sulphur.
Pyrites	100
Calcium sulphate	91
Barium sulphate	91

These results must not be taken as absolutely indisputable, but approximate only. They show how readily sulphur in any combination is liable to be retained by the iron in the blast furnace. It seemed reasonable to believe that the bases calcium and barium associated with the sulphur in calcium-sulphate and barium-sulphate must check the sulphur from passing into the iron, but as a matter of fact their influence in that direction is very feeble. To place the question absolutely at rest, the comparative smelting should be done in gas-fired furnaces, and the temperature be controlled by pyrometer. This I hope to effect before many months have passed.

I acknowledge with gratitude the assistance of Mr. Bambridge and my other assistants.

Discussion.

MR. DONALD LEVY, of Birmingham University, followed with a short speech, in which he maintained that in cast iron the effect of sulphur in moderate amounts was due to its keeping the carbon in the combined state, the sulphide of itself having practically no direct weakening action; any other circumstance which kept the iron white was quite as bad. The weakness and brittleness of white iron was intrinsically due to carbide. In steel it was the direct weakening action of fusible sulphide boundaries round the crystal grains which rendered the steel red-short.

MR. T. MACFARLANE challenged a statement by MR. STEAD that sulphur in the coke is not so liable to pass into the metal as sulphur in the ore. His experience was quite the opposite. Sulphury coal was more apt to give a sulphury pig than was a sulphury ore.

MR. BUCHANAN mentioned an experience showing the effect of cooling on sulphur. On one occasion when he was slagging a cupola a slag deposit three or four inches thick took about 120 hours to cool. At the same time he made a thin casting which cooled in 30 minutes and contained 0.508 of combined carbon, whereas the slag only had 0.020.

MR. HAILSTONE expressed his indebtedness to Mr. Stead for his hints on sulphur printing given in a previous lecture, which he had found invaluable. But he thought it important that the period of contact should always be the same for comparative purposes. Numerous experiments with foundry iron did not support Mr. Levy's view that managanese or chromium would have the same hardening effect as sulphur. In making cylinders for high-speed engines he had always found, and he believed Mr. Cook, the President of the British Foundrymen's Association, had the same experience, that by hardening cylinder iron with sulphur it was possible to give the cylinder a longer life.

MR. STEAD, in acknowledgment of a vote of thanks, said that all research, no matter how imperfect, was like grain put into fertile soil and yielding fruit a hundredfold. Mr. Levy had stated that sulphur was only bad in pig-iron by making the iron white. Foundrymen would perhaps take exception to that statement. Pig-iron high in sulphur was a mixture of iron, graphite, and particles of what was equivalent to slag, whereas in the case of white iron formed by chromium or manganese there was an absence of slag. He should say that the whiteness produced by manganese or chromium was not so harmful as the whiteness produced by sulphur, for the simple reason that in one case they had slag plus iron interspersed throughout the mass, and in the other they had not. As to sulphur being good for wearing surface, it was rather doubtful whether the strength of the iron would not be less if a certain amount of combined carbon were produced by sul-

phur than if produced by manganese. He thought hundreds of blast furnacemen would be very glad to believe that sulphur was not more harmful than manganese or chromium. He hoped that would prove to be true. He could hardly agree with the idea that high sulphur in the coke was more detrimental than in the ore. When in the coke the sulphur was not given up until it reached the tuyeres, whereas if it was initially present in the pig-iron the slag had to do the purification.

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THE SAND BLAST IN THE FOUNDRY.*

On the subject of cleaning castings, it may be said that, until quite recently, this work has been done by means of pickling and tumbling; both of these methods are well known and reliable, but more recently there has been a strong demand for cleaning by means of the sand blast.

It is thought by many that a sand blasted surface will hold paint more firmly than the surface cleaned by pickling. Some two years ago our attention was called to the use of sand blast tumbling barrels. These are adapted to cleaning comparatively small castings.

This apparatus includes a supply of compressed air at 15 to 20 lbs. pressure and an elaborate exhaust system for the continuous supply of sand and for the removal of fine dust. This fine dust has been difficult to control, but this has finally been accomplished by passing it through a wet scrubber, as it is called. This scrubber consists of a stack or trunk about 7 ft. square and 25 ft. high. This stack stands in a water-sealed base and is fitted with a series of wooden racks or slats, over which a flow of water is circulated by means of a centrifugal pump. These racks are so placed as to break up the passage of air through them. They offer a very large area of wet surface to the dust-laden air, and in passing through them the dust is practically all deposited on the wet racks and is washed to the bottom, from which it is removed from time to time. This wet scrubber receives the dust, not only from the sand blast barrels, but also from the regular tumbling mills and, while it is not strictly speaking an essential part of either, the total amount of dust discharged is so great as to constitute a serious nuisance if blown into the open air and, except in any isolated situations, some efficient dust separating device must be provided.

The work done by the sand blast barrels is very satisfactory in both quality and quantity, and the direct labour cost is no more than the cost with ordinary tumbling barrels, but the cost of installation and the cost of maintenance are both high. The installation of the sand blast barrels must, therefore, be justified by quality of the work done, rather than by its cost.

Sand Blast for Large Castings.

Recently the question of applying the sand blast to machine frames and other castings too large for the barrels has been much discussed.

The question is not as to the merit of the sand blast, but as to the feasibility of taking care of its dust and dirt, and operating it under fairly comfortable conditions for the operator. The arrangement of such an installation will be of interest, because we have made it successful to this extent.

The sand blasting is done in a room built within the cleaning room proper. This room is 15 ft. square and 8 ft. high. The work to be cleaned is suspended from an overhead tramrail with an electric hoist.

A slot in the roof of the room allows for the proper placing of the piece to be sand blasted, and the roof of the room protects the hoist from any injury. The room is ventilated by means of a Sturtevant steel plate exhauster with 18-in. suction and discharge connections. This exhauster is run at 1,260 revolutions per minute, and gives a free circulation of air through the room. Air is admitted to the room from the opposite side and as near to the operator as possible. The intention is to supply the operator with ample fresh air and to draw the dust away from him. The space between the operator and the dust outlet on the opposite side of the room is some 10 ft., and gives time for the sharp sand to fall to the floor, so that only the light floating dust is drawn out of the room. The sand can thus be easily shovelled up and used over repeatedly. The dust is discharged through a wet scrubber, similar in principle to the one used for collecting the dust from the sand blast and other tumbling barrels. The fitting up of this sand blasting room, including its exhauster, its motor and wet scrubber, has

* From a Paper by W. T. Hatch read before the N. E. Foundrymen's Association.

been quite an expense, to say nothing of the power required to operate the sand blast and the exhauster; still the quality and quantity of work done with this apparatus are very satisfactory, and if it be admitted that sand blasting is necessary, I believe our installation must be considered a success. As in the case of the sand blast barrels, however, the cost of installing, operating, and maintaining the sand blast apparatus is high, and the quality of the work done, rather than its cost, must be the reason for its adoption.

FOUNDRY SAND CONVEYING.

THE need of mechanical conveyors for distributing sand in foundries is emphasised where moulding machines are in use, because the advantage of the machines depends largely upon the sand supply. Two types of apparatus stand out prominently in this work—the belt conveyor and the reciprocating conveyor. The former well fits the conditions when the sand is to be carried on straight or slightly inclined runs for a single discharge over the end of the conveyor; but

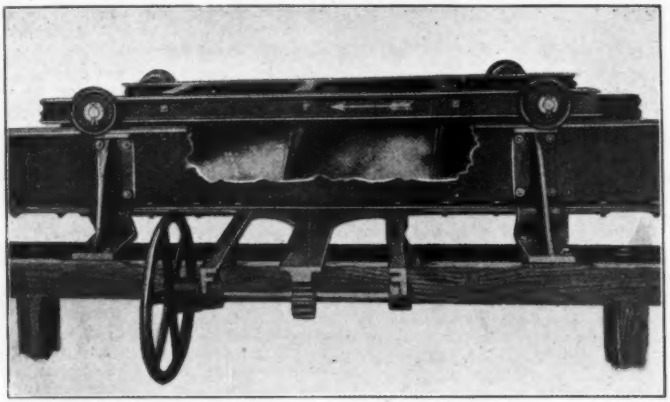

FIG. 1.—FORWARD MOVEMENT OF CONVEYOR.

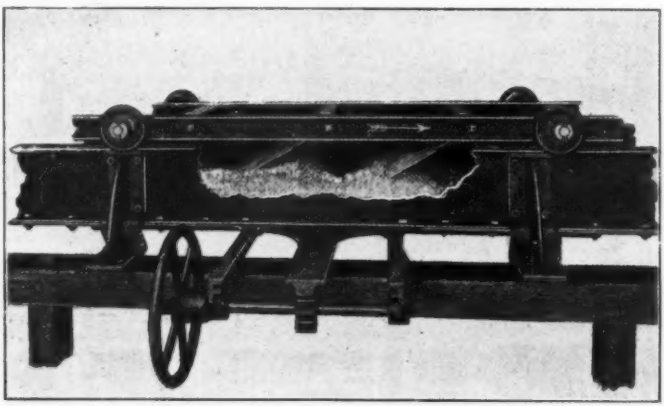

FIG. 2.—RETURN MOVEMENT OF CONVEYOR.

if arranged for a number of deliveries, or for a single delivery at any point other than over the end, a tripper, usually cumbersome and heavy, is necessary, and the reversing pulley of this tripper subjects the belt to excessive wear both by the added strain imposed and the continual grinding in of sand. A conveyor of the reciprocating type, however, is easily adapted for delivering at several points. The illustrations, Figs. 1 and 2, show the details of such a conveyor, which consists of a trough for holding the material, surmounted by a steel frame on wheels, which carries hinged flights extending down into the trough. Reciprocating motion is given to the frame and flights by a crank mechanism. When moving forward the hinged flights push the material along, as in Fig. 1, while in the reverse movement back to the starting point, they drag over the top of it as in Fig. 2. A noteworthy feature is that the working parts—which are few—are entirely away from the materials handled; consequently they are less subject to wear.

The conveyor is manufactured by the Link-Belt Company, Philadelphia, U.S.A.

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CORE BINDERS.*

By E. D. Frohman.

The ideal core compound is one that makes a good plastic core when green; strong, open, tough when dried, which will not swell when baked, but will fit right into the core box. It should not break off from the rough usage and handling in the foundry, and when the iron is poured should break up and literally run from the mould, and under no conditions should it absorb moisture. Truly this is an ideal state, but it has not yet been reached, even if the average foundry supply salesmen think they have it. To accomplish this has been the aim, ambition, and desire of every manufacturer. It is true that these conditions can be brought about where the question of cost does not enter, but in this every-day world of commercialism, where cost is an ever important item of consideration, our ideal must be within the limits of reason and at a cost within reach of every foundryman. So much for ideal. Now let us take the individual raw materials which are used in the manufacture of cores in every-day use in the foundry.

* Read before the Pittsburg Foundrymen's Association.

Flour.

No one will deny that more flour is used in the making of cores than any other single class of raw material. We will leave out the item of adulteration of flour, which is known to every foundryman to his great disadvantage and cost. It is only the pure, high grade flours that we will discuss. Now let us study flour; first its action when green, when baked, and when shaken from the mould. In the first place, when plenty of flour is used in making the core we have an excellent green sand core; but one of the greatest disadvantages where a large quantity of flour is used is the swelling when the core is baked, not to say anything of the serious objections of the castings being lost by blowing and their cleaning cost.

To blame the flour, when used in excess, because of blowing would not be fair, as blowing with any compound can be brought about by the strong arm of the coremaker. Should the coremaker ram the core too hard in spots, it is very apt to cause blowing. It may sound strange, but very often cleaning costs are advanced on account of the use of flour, the core not cleaning out as readily as one would suppose. Another of the great disadvantages of flour is its fluctuation in the market. The foundryman figuring his coreroom cost must look at the daily flour market quotations and find where he stands.

Resin.

Resin, formerly a residue in the manufacture of turpentine, now a by-product in the manufacture of turpentine from yellow pine, is undoubtedly one of the best materials for making cores, and approaches nearer to the formula given as an ideal core compound than any other on the market. The only objections I have been able to find are the smoke and baking, and its price. This makes it a rarity for foundry use. Resin surely makes a solid core when dry, and the addition of loam sand makes a good green core sand when dry, and it does certainly clean readily from the castings when the iron is poured, but the cost is rapidly eliminating resin for foundry purposes.

Dextrine.

Dextrine makes a green, plastic core, and if used in proper proportions is all that can be desired. Again the item of cost comes into play, from the fact that pure dextrine is out of proportion in its cost for the use that it may be put to. When it is sold cheaply so that the foundry can use it, it is either in the form of adultera-

tion, or what is called floor dust, and contains various proportions of starch, dirt, and what not, making it an expensive core compound. It must be watched exceedingly closely not to have too much of the dextrine, as absorbing moisture and blowing can only be avoided by having the right proportions to the sand in question; but if used properly it will clean out readily from casting and is of great value. The users of dextrine must watch their sand more closely than is necessary in any other mixture that can be used.

Patent Mixtures.

Then we have patent mixtures, consisting of treated flour or starch or a celluloid compound, so-called jellulose. This is simply flour treated with caustic soda or chemicals to convert the starch in the flour to dextrine, thus giving a greater green-sand binding and the chemicals giving the sand great strength when baked. The cleaning cost is the only item that must be watched in a case of this kind, the chemicals burning in and preventing the sand from breaking from the mould.

Bitumen and Glue.

Bitumen, or asphalt, is absolutely no good when used by itself, as the bitumen bakes hard in the oven, and when the heat of the iron strikes it the core does not break up as one would suppose, but becomes harder than ever. Many a time the writer has seen the cleaning floor worked for hours to clean out a core made with this class of material.

Glue itself may sound strange to the ordinary foundry. When dissolved in water and boiled and used in the proper proportions it makes a very good core. Absorbing the moisture, however, and blowing when the castings are poured offer two serious objections, and it must be watched exceedingly closely in order to give any good results whatsoever.

Oils and Glutrine.

Now come the various oils. There is no question that linseed oil makes an exceptionally fine core, and it is one of the best core compounds, but that ever used four-lettered word, cost, which must be heeded in the ordinary foundry practice of to-day, prevents its use. Linseed oil makes an exceedingly strong core when dry, but a very poor green sand core, and forms must be used with this as well as oil cores when baked. Another oil used to a great extent in the foundries in the East is fish oil. Its ill-smelling properties make it obnoxious for many foundries to use, but it has excellent qualities, and in many ways is equal to linseed oil. Corn oil is also an exceptionally good oil, having, however, its faults of not being quite as strong as fish oil and linseed oil, and it will not spread over the sand like linseed oil. Therefore, core oil manufacturers use small proportions of the various oils, such as linseed oil for strength, and corn oil and petroleum or mineral oils for spreading the oils over the various sands. It can be readily seen that by using different proportions of the various oils mentioned above, by figuring permutations and combinations, almost 100 mixtures of different kinds of oils can be placed upon the market, all having merits. Glutrine is a residue of paper mills. In the manufacture of paper the wood is treated with sulphite and magnesia sulphite in large digesters. The lime and magnesia sulphite eat out the resins from the wood and leave the jellulose, which is called the wood pulp. The liquors contain the resins of the wood which give the green-sand binders, while the lime and magnesia give bond when the materials are baked. The sulphur in the compound is apt to affect the iron of the casting.

"Esso" and "Kantbebeat."

"Esso" core binder is the juice of various plants treated with chemicals which will not absorb moisture. The juices of the plants give the green-sand binder and the chemicals bind the core when baked. The extreme heat of the iron breaks up these chemicals and causes the core to clean readily from the sand. There are many advantages in this material. One is its cheapness and another is the readiness with which it can be used. It goes as far as 60 parts of sand to one of core binder, and the writer does know of the use of 100 parts of sand to one of core binder. No doubt many other materials can be used in the manufacture of core compounds, but are excluded on account of cost.

"Kantbebeat."

Now let us take the bitumen compounds, of which "Kantbebeat" is one. This contains one of the ideal materials spoken of before, as the highest quality of material for giving it a good green sand body; the bitumen giving it the bond or body when baked and having materials added to it which will burn up readily when the iron is cored. Permutations and combinations were tried in the laboratory of the makers to the extent of over 200

different kinds of dry compounds until they found what was desirable. This material had to be manufactured so that it could be shipped large distances, so that it could be kept in stock from three to six months, and even a year, and not spoil; it had to be made so that it would be acceptable to almost all sorts of conditions of sand.

"Kantbebeat" core compound for heavy work is used with 10 parts old core sand, 10 parts loam-moulding sand, 10 parts sharp sand. The temperature for the mixture is about the same as for flour cores. The point aimed at is a core that must be well heated in order to have it cleaned easily and readily from the casting. If the heat is not of a high temperature the cores are apt to bake extremely hard. This compound is of extreme value to foundrymen in green-sand work, when used at the ratio of 15 parts of moulding sand to one part of "Kantbebeat." It has the great advantage of not swelling or warping, and doing away with the sea coal facing generally used in the sand and also for skin-dried work. This is especially of advantage where charcoal fires must be used for skin drying.

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SOME LIMITATIONS OF THE MOULDING MACHINES.

THE American Society of Mechanical Engineers publish in their proceedings the following discussion contributed by Mr. Ronceray on the above paper by Mr. E. H. Mumford, which we published in January last.

Mr. Mumford mentioned exceptional cases (says Mr. Ronceray) where it might be necessary to provide for double-ramming, that is, ramming deep pockets from the mould face independently, and his presentation of the case, according to my experience, is characteristic of the condition of machine moulding in America. In that country the power pressing moulding machine has been applied especially to shallow castings. It has been quite a different proposition on the other side of the ocean, governed largely I suppose, by the peculiar requirements of the trade. There is very little repetition work there, while on the contrary there is a considerable amount of it carried on here. We have perhaps more exacting conditions to meet; that is why, no doubt, it has been found necessary to ram deep parts in the mould; and this is the reason for the presence of what we call "double-ramming."

It is well understood that after the mould has been rammed from the top, the stool is given additional pressure from the bottom. This method is used for special cases; it is not for general ramming around deep patterns.

This occasion gives me an opportunity to describe a new moulding machine, illustrated in Fig. 1 and Fig. 2. Take for instance, patterns shown in Fig. 1, for a projectile, which shows the usual shape. It is expedient to have several projectiles in the mould, but only two

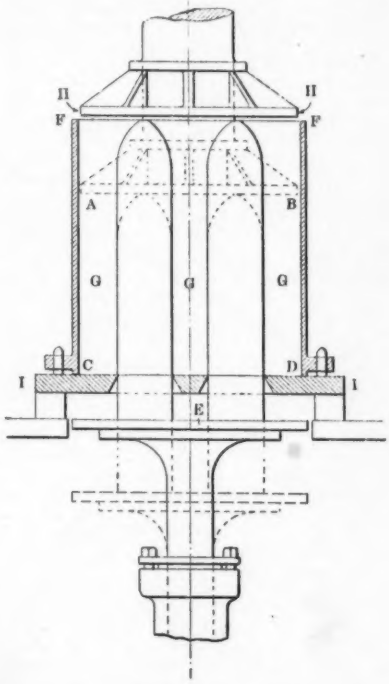

FIG. 1.—A PATTERN FOR A PROJECTILE.

will be shown, that being sufficient for the demonstration. The difficulty in trying to ram sand around too small pieces like those described, is well-known. The problem has been solved in this way; the patterns have been made longer than necessary for the mould itself, A B C D as shown, and they are mounted on a plate E on a piston which has a vertical motion. The sand is placed in the flask, and the sand frame up to the level F F. The sand is rammed in, as on an ordinary moulding machine, except that on an

ordinary machine it is evident the sand would not be rammed at G G G, even if the patterns were fixed at the position shown by the dotted lines and sand rammed over them; the friction of the sand would interfere with the ramming. As shown in the sketch, the descent of the ramming plate H H carries patterns and sand down together until checked at the surface A B by an adjustable stop, and a perfectly rammed check is made. When sand is rammed over the patterns, and the patterns are pushed down through the stripping plate I I by other means than actual contact with the patterns themselves, so leaving sand over them, a complete half mould, instead of a check, is formed. This method

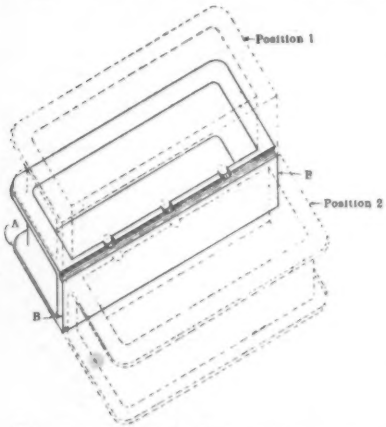

FIG. 2.—A SPECIAL SET OF PATTERN-MAKING FLASKS.

has been tried on difficult work, and it is a very effective way to ram deep sand without hand work.

The author mentions that the product of stripping pattern plates requires great accuracy. There are stripping plates on which the cope and the drag part of the pattern are put alongside of each other. Great accuracy is obtained by a special set of pattern-making flasks, as shown in Fig. 2.

A is one-half of an ordinary flask, cut in the middle, and flanges and a fourth side are put on at B B and finished with great accuracy. What Mr. Mumford has called a foundry jig comprises two of these half flasks, and a single cope flask.

Placing the second half of the flask over the first, and ramming it up, as a cope mould on any patterns lying in the joint, the planed sides being held accurately in the same plane by bolts and dowels, in position 1, and then lifting this cope and rolling it back into position 2, we obtain a duplex drag mould in which every part of a mould in one-half is absolutely opposite every homologous part of the mould in the other.

Over this duplex drag a one-piece cope mould, which has been separately rammed up, is placed upon a frame which constitutes a special check of small depth, and the pattern plate run in this three-part mould will leave the reversing principle embodied in it by virtue of its method of manufacture.

Reversing stripping plates are made in the same way except that they are made in the joint itself without the check frame.

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SPONGINESS ON THE UPPER SURFACE OF CASTINGS.

By D. WILKINSON, JUNR.

WHEN a casting is being machined, irritation is frequently caused in the foundry by the discovery of a number of small holes and dirty places, usually called "sponginess," as the skin is being taken off. The machinist, being a capable exponent of his own craft, imagines he is competent to settle any question arising on the subject of castings. So as the job progresses and spongy places are laid bare, he issues sundry bulletins which clearly show how little he understands the matter. Naturally enough, the moulder fails to convince him that his opinions are erroneous, and so is sometimes led to make a few remarks that are foreign to the point at issue. Then the irritation becomes mutual.

How to get rid of this sponginess has puzzled generations of moulders. With a regularity that becomes monotonous, castings, upon machining, are found to have the upper surface thus disfigured. So much so, that most men have ceased hoping to overcome it, and only seek to confine it to places where it will not be laid bare or where it will be least injurious. We sometimes hear of nostrums which will cure it; much in the same way we sometimes hear of the sea-serpent. The one is usually found to be as genuine as the other.

Careful examination of a number of spongy places will show two varieties of sponginess. Of course, skimmings and the sand from scabs are not included here, since they are preventable and do not properly come under this head. In

addition to these, two distinct classes of imperfection will be found. One is a small hole, of varying size, something like a bubble, and quite smooth on the sides. The other is a patch of dark-coloured scales or grains which can sometimes be scraped out, leaving a rough depression. This is usually distinguished as "dirt."

Let us consider the case of the "dirt" first. One wonders how often moulders have been accused of not skimming clean, or of not arranging their gates properly and so allowing this dirt to get in. We should need an extension of the multiplication table in order to compute it. But no matter how clean the iron is skimmed, nor how carefully the gates are arranged—and I have seen some weird contrivances in this line—it is impossible to keep it out of the casting, for the simple reason that it actually formed in the mould while it is filling.

When the molten iron enters the mould. "dirt" from three distinct sources at once begins to accumulate. First, there is a certain amount of erosion of the mould by the flow and heat of the iron. The dust thus formed naturally floats on the top of the metal; and should it by any means accumulate in one place, there we have dirt spot No. 1. Secondly, there is the oxidation of the different constituents of the iron, which forms an impure and cindery oxide of iron. With this may also be classed any particles of slag mechanically retained by the metal. It needs but a glance at a shank of molten iron to notice particles of slag and refuse rising or forming on the surface. If the mould is of any size the amount of air it holds will exert an appreciable action on the iron; while the agitation of the metal as it is filling the mould will assist the liberation of any slag mechanically retained. The whole will rise to the top and add to the number of dirt spots. Thirdly, there is the action of the steam generated by the heat of the metal from the moisture in the sand. Chemical action is at once set up between this steam and the molten iron with the formation of oxide of iron and hydrogen gas. The hydrogen escapes and burns with the well-known blue flame. The iron oxide, however, cannot escape; and being lighter than the iron, rises to the top and so increases the number of patches, large or small according to circumstances, of dirt. This oxide is of exactly the same composition as the scale formed at the blacksmith's anvil. The amount will vary with the moisture in the sand, the temperature of the iron, and the time occupied in filling the mould. However careful the moulder may be, dirt from these three sources will, in a greater or lesser degree, accumulate in every green-sand mould.

Since this dirt cannot be kept out of the mould, can it be cured when it is in? If the iron is at a sufficiently high temperature, it provides its own remedy for part of the disease. As is well known, if a mould is filled quickly with a good quality of iron as hot as it can be melted, generally speaking the resulting casting will be fairly clean and free from dirt.

The iron oxide is reduced again to metallic iron by the action of the carbon present in the metal. But this reaction can only take place when there is a large amount of surplus heat. In the language of thermo-chemistry, it is strongly endothermic; that is, it absorbs heat in occurring. The amount of heat required to complete the reaction between the formula weight in grams of the two substances (non-oxide and carbon) is about 150 large calories.* Hence the necessity for having the iron as hot as possible, since no other source of heat is available in this case.

Unfortunately, many of the ills castings are heir to follow in the train of very hot iron. It means increased erosion, and increased erosion means rough surfaces and greater accumulations of dust in the top of the casting. It also means liability to shrinkage holes and increased liability to scabbing, so that unless the greatest care is exercised much more will be lost than gained. A well-made mould for light, thin castings will stand the iron as hot as it can be melted, but such iron is anathema to moulds for heavy castings. In such a case it is better to chose the lesser of two evils.

Let us now turn to the other defect, the small holes or bubbles. These are frequently spoken of as pinholes or blowholes. I suppose they are called pinholes because, when they are only just cut into, a pin is sometimes used to explore them with; but to call them blowholes is, indeed, a misnomer. They are no more due to a blow than to a lunar eclipse. A blow is a rush of gas and steam through the metal. It results from the sand being too damp, or rammed too hard, or not being properly vented. Hence, steam and gas is generated faster than it can pass away through the mould, and so has to come up through the metal, sometimes doing so with explosive violence. The con-

* A "calorie" is the amount of heat needed to raise the temperature of 1 grain of water 1 degree Centigrade. This amount of heat is too small for convenience in thermo-chemistry, so the large calorie is used. This is the amount of heat needed to raise 1,000 grains of water 1 degree Centigrade

tents of a mould that has blown is usually a piece of rough scrap. The small holes now under consideration, however, are seldom visible until the upper surface of the casting has been machined.

I was rather surprised to find when reading a work on "Ironfoundry," recently published by a gentleman whose name commands the respect and attention of all foundrymen who are trying to keep abreast of the times, that even here the term blowholes is applied to this defect, and it is stated that sometimes they are caused by want of proper venting, or by too much moisture in the sand.

The real cause is entirely different. It is a well-known fact, that most metals when melted absorb a certain amount of gas from the atmosphere or some other source. The greater part of this dissolved gas is given off upon solidification, but a proportion of it is retained. This retained portion is said to be occluded. The occlusion of gases by metals has been made the subject of research by metallurgists, and it is definitely known that iron occludes, that is retains when solid, oxygen, carbon monoxide, nitrogen, and hydrogen. Now, the first three of these gases can be dissolved by the iron in the cupola as it is melting, and the hydrogen in the mould from the decomposition of the steam; and my contention is that the small holes we are discussing are formed by the excess of these gases dissolved in the molten iron, as they are liberated when the iron is nearing solidification.

Observation has made me acquainted with somewhat similar projected portions of metal on the splashes of iron resulting from careless casting or from a "run out." I have often watched these splashes cooling, and have seen the spirting take place. Fully 10 per cent. of the smaller fragments I have examined have shown unmistakable signs of its occurrence; and in a much larger number it has appeared to have occurred, but the appearances were not conclusive.

These projections must by no means be confounded with the exuded particles of sulphur eutectic sometimes seen on scrap, gates, etc. These can always be distinguished by the fracture, and frequently by the ease with which they can be detached. Often they can be scratched off with the finger nail; and when broken and examined with a lens show a white, specular fracture. The projections due to spirting, however, are almost invariably firmly attached, and when broken show a grey fracture exactly similar to the metal on which they occur. I have found both sorts on a piece of splash-iron no larger than a shilling.

The place in which spirting occurs most frequently is on the side, just where the flat top of the splash of metal curves down to the bottom. The projection occurs in such a position, and at such an angle, that it is obvious it could not have been there when the iron was molten, but must have been thrust out after partial solidification had taken place. They are rarely seen on large pieces of scrap.

Let us consider the case of a mould filled with molten iron. Held in solution will be an amount of hydrogen, oxygen, and carbon monoxide. As the metal cools towards its freezing point, the excess of these gases over and above the amount it can occlude (retain when solid) will begin to separate out. The separation takes place in the same manner in which the excess of a salt dissolved to saturation in boiling water will separate out as the water cools. We shall then have a number of gas bubbles up and down the casting. Of course, these bubbles at once begin to rise through the yet liquid metal, and they continue to ascend until they arrive at the top, or until they are stopped by some projecting portion of the mould. Here they would pass away through the sand could they get to it. But the cold sand has set the iron lying next to it, and the thin skin of solidified iron, backed up and strengthened by the mould, prevents the bubbles from reaching and passing through the sand. So perforce, they remain where they are; that is, under the skin, where they are found on machining.

That the gas bubbles are liberated in every part of the mould is evident from the fact that the upper surface of any projection, whether near the top or the bottom, is liable to be pitted with them. Also they sometimes are to be seen on the bottom of a casting. But here they are very rare indeed, and always small. They are probably some of the last to separate out, and have been prevented from rising by becoming entangled among precipitated scales of graphite. I have frequently broken long down-gates in order to examine the fracture for these bubbles, and have found them in one's and two's at all distances from top to bottom. These cases, however, are exceptions. Generally speaking, all the bubbles rise to the top of the casting.

Several scientific writers of repute say that an increase in the amount of silicon will overcome this difficulty and produce sound castings. In proof of this they instance white iron, in which the silicon

is low, and which produces castings more liable to what they erroneously term blow-holes, than grey iron containing a greater percentage of silicon. We will concede the greater liability of white iron to this defect, although the point is debatable. I have seen castings of good, grey iron which would take a lot of beating in this direction; and I have seen malleable iron castings which have machined quite clean. But no increase in the percentage of silicon will prevent these bubble holes forming.

Quite recently I saw some castings made to a special order from a mixture containing silicon pig, which would give a casting with about 4.5 per cent. of silicon. By a misunderstanding the part to be machined was cast uppermost, and, despite the high percentage of silicon, the bubble holes showed up as usual.

Aluminium also, is said to prevent their formation. I have seen experiments carried out with this metal, but it did not do away with them. The only way in which the number of these holes can be reduced, and an occasional casting be obtained free from them, is by pouring the metal as hot as it can be melted. Where practicable, this gives far better results than any "doctoring" of the iron does. When a casting is poured as hot as possible, the metal is able to heat up the cold interior of the mould without a thin skin of solidified iron forming next to it. The whole body of metal remains molten. So when the gases are liberated as the setting point is being neared—for the gases are always liberated, and not retained in solution—they can, on arriving at the top of the casting, pass away through the mould and are not kept in by a coating of solidified metal. Only the last few to separate out are liable to be unable to escape on account of the outside of the casting setting.

In order, therefore, to secure a casting with the least amount of dirt and the smallest number of bubble holes, it is necessary to pour the metal at a high temperature. This is the old-fashioned method; and it would seem we are as far off any improvement on it to-day as ever we were. The thing to be regretted is that the evil results of this action are sometimes greater than the evil it minimises. In avoiding the Scylla of sponginess the moulder is likely to fall headlong into the Charybdis of shrinkage holes, scabbing, and roughness; and even then it is impossible to guarantee the complete absence of sponginess. The high temperature only removes the iron-oxide formed by oxidation and by the decomposition of the steam, leaving the cindery, slaggy matter and the dust from the erosion untouched. No one can be certain that all the dissolved gas will be liberated before the outside of the casting has set, and none retained as bubble holes.

I have for years kept a close watch on this matter, but have not found it possible to state definitely whether or not a casting will be clean when the top side is machined. I remember once making two flat discs about 8 in. diameter, weighing 10 lbs. or 12 lbs. each. They were to be machined all over, and there was only sufficient allowance for a very slight cut. I made both moulds, each with a gate and riser, in exactly the same manner, and they were both cast from the same shank of clean, hot iron. The one faced up splendidly, but the other was anything but satisfactory, although no difference was to be seen before machining.

Quite recently I had to make two pairs of pattern plates for moulding machines. They were 1 in. thick, and weighed about ¾ cwt. each. The top side had to be machined for about 4 in. on each end to form a seating for a trunnion. As the bottom side, which gave the working surface, was rather intricate, I took every precaution to secure a satisfactory result. In order to minimise the risk of erosion and scabbing, I cast them from each end, distributing the flow of metal into the mould as much as possible. Each plate was cast separately, with two 90-lb. shanks. Both shanks were filled at one tap from the furnace, and the moulds were cast as hot as I thought it safe to venture. Three of the plates when the trunnion seatings were machined proved clean. Very little sponginess was to be seen. The other one, however, was different. One end was quite clear, but the other end was simply full of bubble holes. And the only explanation I can find for it is that there must have been a slight difference, so slight as to escape notice, in the temperature of the iron in the two shanks. So the bubbles of gas at the one end were able to escape, while at the other end they were prevented doing so by the somewhat cooler iron forming a skin on resting against the cold mould. It made no difference to the working qualities of the plate, but it was rather provoking.

The sooner it is recognised that at present it is impossible to regularly obtain a clean, sound upper surface to castings, for the simple reason that the causes of unsoundness are entirely beyond control,

the better it will be for the moulder's peace of mind. There is, as yet, only one royal way to soundness; and that is, to cast the part to be machined downwards. It will be free from sponginess then. If circumstances compel it to be on the top, then make a liberal allowance for cutting off, and so get rid of the unsound part in that way. It can be laid down as an axiom that the top side of a casting will certainly be more or less spongy; and it is surely little use kicking against the inevitable. Some day, perhaps, a way to overcome it may be discovered. May that happy day come quickly.

CAST-IRON TROUGHS.

By W. P.

A number of lengths of the troughs shown in Figs. 1 and 2, were recently required for a washing-out plant. There are several ways of making the pattern, and each may have distinctive merits to suit certain circumstances. In the first place it must be understood that the quantity required made it advisable to have an iron pattern, also that in order to have the castings straight when cast, it is necessary to have some camber in the pattern. From pre-

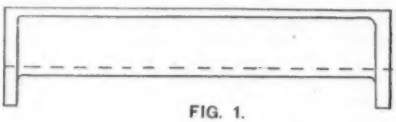


FIG. 1.

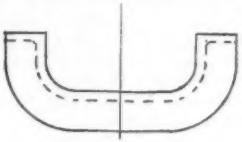


FIG. 2.

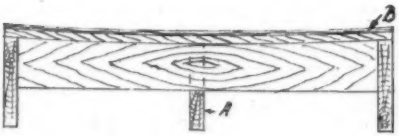


FIG. 4.

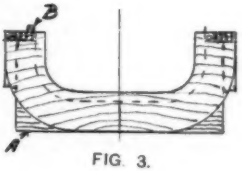
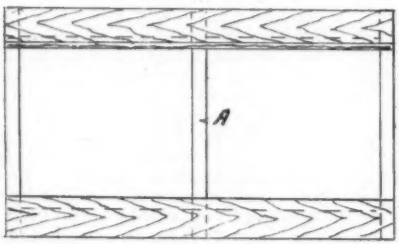


FIG. 3.



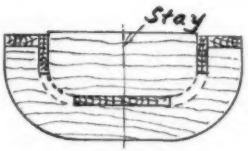


FIG. 5.

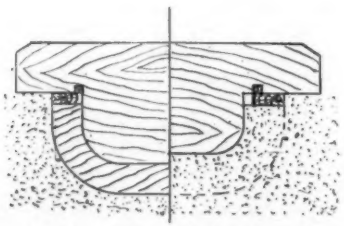


FIG. 6.

Pattern for a Cast-Iron Trough.

vious experience we expected this to be about $\frac{3}{16}$ in. for each casting, that is $\frac{3}{16}$ in. for the iron pattern and $\frac{3}{16}$ in. for the finished trough, or in the first instance $\frac{3}{8}$ in.

To make a complete pattern in the first place would be an expensive job, and only in a place like a Government yard would such a luxury be entertained.

One reasonable way would be to make it with a bottom, and two sides, with flanges attached; leaving the corners to be strickled after bedding in the pattern, as shown in Fig. 5. If made in this way it would be necessary to have two or three stays fixed inside to prevent the sides from being rammed in when moulding.

The method we adopted was as follows: Figs. 3 and 4 will give some idea as to the construction. Two boards were got out about 6 in. wide, $1\frac{1}{4}$ in. thick, of a length to go between the flanges, the top edge of each board being worked to suit the camber. The two longitudinal flanges were then screwed, one on each rib. The end flanges and a centre stay, A, Figs. 3 and 4, were next fastened in position. The centre stay, as its name implies, is only put in to prevent the sides being rammed in, and is filled up afterwards. A strip of wood, B, Figs. 3 and 4, was fastened on one flange to act as a guide when strickling the inside portion. Fig. 6 shows two half-sections of strickles as used, one for inside and one for outside of the trough.

Moulding.

The frame was bedded in and the sand rammed fairly hard. The inside was strickled out to the smaller size, which formed the inside of the trough. The mould was then covered with parting sand, the cope put on and rammed up in the usual way. After this was lifted off the second strickle was used to form the outside; the frame was then drawn from the sand and the cavities formed by the centre and longitudinal stays were filled in, the mould finished off and made ready for pouring.

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A RUMOUR has gained currency during the month to the effect that negotiations are now well advanced with the object of amalgamating a number of marine engineering works on the North-East Coast. Enquiries made at many of the most important works have been profitless so far as regards any information on the subject, but it is generally admitted that negotiations are proceeding at present with this object in view.

DOUBLE-LIPPED CRUCIBLES.*

MANY brass founders are apt to look with derision upon the use of two lips upon a graphite crucible, while others continually use them and consider them quite advantageous. There probably is no more diversity of opinion upon any part of a crucible than upon this one. Many brass founders say that they do not desire any lips at all, as they soon become obliterated, and a fresh groove must be cut in the edge from time to time when the crucible has had a considerable number of heats.

There are many instances, however, in which two lips are advantageous, and if a brass founder would lay all prejudices aside, he would find that his moulders

DOUBLE LIPPED CRUCIBLE.

would be able to pour the flasks more rapidly and, perhaps, with greater certainty.

Take, for example, a bench moulder who has a "heat" to pour. His flasks are set upon a spill trough, and the flasks on one side of the trough are poured, and then, in order to pour the other side, the crucible must be turned around. This is accomplished either by the helpers actually lifting the tongs and crucible up and turning it around, or by removing the iron rod which passes through the eye of the tongs, while the crucible rests upon the spill trough, and then turning

* "The Brass World."

crucible and tongs around. In either case, helpers occasionally will hit a flask or otherwise injure it. If a large crucible is used, it may not enter between the rows of flasks and the turning becomes more difficult.

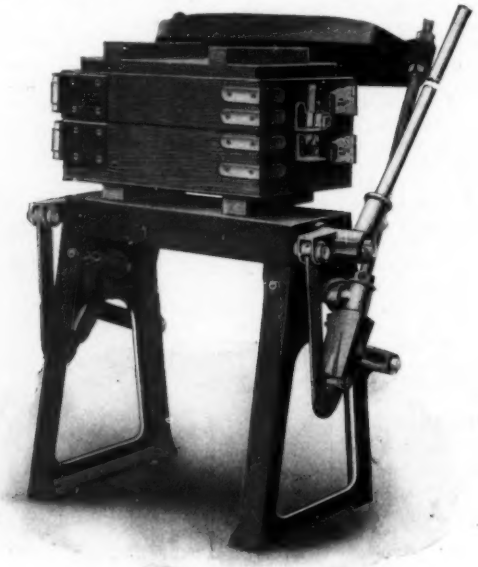
A crucible with two lips is shown in the illustration, and if used for the purpose previously mentioned, no turning is necessary. The moulder simply changes his own position to the other side of the spill trough, but the crucible, tongs, and helpers remain where they are. The crucible is ready for pouring on either side and the danger of disturbing the flasks is obviated.

In the brass rolling mill the double-lipped crucible is frequently useful. If the moulds are placed opposite one another in a pit, then the same method may be used as that employed in the instance previously mentioned. Some brass casters prefer a double-lipped crucible on this account.

As a double-lipped crucible costs no more than one which has one lip, and its life is not shortened in any way by the presence of the second lip, crucible users have nothing to lose if they use them and they are found wanting.

A HAND-PRESS MOULDING MACHINE.

THE machine shown in the illustration is capable of taking in boxes up to 18 in. long by 15 in. wide, and is adapted for light repetition work where a deep lift is not required. The machine is shown with the boxes ready for pressing the last box. In bringing over the lever at first, the press plate is moved rapidly over the top of the box, and upon a further application of power to the lever, a vertical downward movement is obtained, which presses the mould.



A HAND-PRESS MOULDING MACHINE.

The process is as follows :—Snap-flasks or ordinary boxes are used with ordinary or "spray" patterns. The odd side is first put upon the table, and the "spray" or pattern laid in; the bottom box is then put on to the oddside frame and filled with sand; a loose mould board is then dropped on to the top of the sand and the iron platen is brought over the top of this by means of the hand lever, the first movement of which brings the platen into a vertical position, as above described. Upon a subsequent movement downward of the hand lever, the platen

is brought downwards and presses the loose board into the box, compressing the sand accordingly.

When this bottom box is made, a loose board is put on to the top and it is then turned over on the table and the odd side lifted from it, leaving the "spray" in the sand. The top box is then put upon the bottom box, sand filled in, the loose mould board put upon the top, and the process repeated with the lever and top pressure plate. The pattern is loosened in the sand in the ordinary way and the top box lifted; then the pattern or "spray" is taken out and the box is put together again, after which the fastenings at the corners are unfastened, when the two boxes will come away, leaving the complete mould standing on the bottom plate ready for putting on to the foundry floor, a loose rough wood frame being put round the mould to hold it together if necessary.

The total weight of the machine is 2¼ cwts. Parted boxes are used for economy and handiness, but, of course, ordinary iron-moulding boxes can be as readily employed.

The makers of the machine are Messrs. Samuelson & Company, Limited, Banbury.

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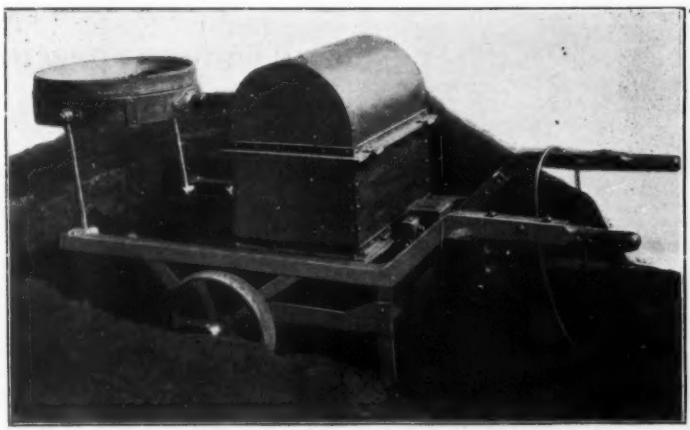
Mr. F. W. Hall, of the Fairbanks Company, has joined the South British Trading Company, Limited, 13, Wilson Street, Finsbury, E.C. Mr. Hall is introducing into Great Britain the Standard Company's weighing machinery.

A PORTABLE ELECTRICALLY-DRIVEN SAND RIDDLE.

All facing and floor sand requires riddling from time to time, but the present-day system of doing this, which requires the services of two men, is both expensive and slow. The cost of labour and materials is continually rising, and it is desirable, therefore, to increase the work done by machines, which are both cheaper and quicker than manual labour. A machine to reduce the cost of riddling sand has just been introduced by the London Emery Works Company, of Park, Tottenham, London, N., and is illustrated herewith.



Portable Electrically-driven Sand Riddle.

As will be seen from the illustration, the machine consists of a trolley, on which the vibrating riddle, as well as the electro motor, is fixed. The latter is housed in a sheet iron casing, which protects it from sand and dust. The motion is transmitted from the motor shaft by spur wheels to a crank shaft, which again transmits it to the riddle by a connecting rod.

The output of this riddle is larger than of an ordinary hand riddle, and it only requires one man to attend to it. One advantage of the machine consists in the ease with which it can be moved to any part of the foundry. The power required to drive the machine is very little, and connection can be made by a simple plug contact from any convenient part of the electrical circuit in the foundry.

It is claimed that this riddle possesses advantages over those constructed for compressed air. The air cylinders for the latter machines are intricate pieces of mechanism requiring constant attention and frequent repairs, and, further, compressed air power is much more expensive than electrical power. With electrically-driven riddles repairs need hardly be taken into consideration.

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A NEW LADLE DAUBER.

THE machine shown in the accompanying illustration is designed for daubing or lining ladles with sand or clay, and is intended to obviate the necessity of daubing these ladles by hand, which entails considerable work. After the old linings have been knocked out of the ladles and after the amount of mud required to daub them is placed inside, the ladle is placed on the machine and is clamped in a rigid position. The plunger is then released and all of the excess mud is forced out through a small space left between the ladle and the plunger. The plunger is designed to shape the lining around the top of the ladle and no further lining of the ladle is required after it leaves the machine. The downward movement of the plunger can be regulated within required limits according to the size of the ladle.

A LADLE DAUBER.

By the use of this machine it is impossible to daub the ladle unevenly, and consequently, there are no irregularities in the amount of metal that a ladle will hold which causes so much annoyance to moulders. The ladle dauber can be connected with any available power, or can be driven by an independent motor. It requires about as much space as an ordinary drill press, and has been designed and is being built by Charles Bartholomai, W. G. Stockham, and G. R. Doming, Piqua, O., U.S.A.

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AN UP-TO-DATE MELTING PLANT.

AN example of an up-to-date melting plant may be seen at the works of Messrs. J. Summers & Sons, Limited, Shotton, Flints. The class of work carried on at these works is of a very heavy description, the cupola-receiver having an extra large capacity. The plant consists of a No. 6 Davies' improved rapid receiver cupola, having a melting capacity of from five to six tons per hour. This cupola is of their standard design 4 ft. 6 in. diameter; it is mounted on four strong columns and is of the drop-bottom type. The tuyeres are placed in two rows and are of special shape giving a well distributed and even blast; the top row of tuyeres are made to close when the charge gets low. The air-belt is provided with fusible metal traps to prevent the accumulation of metal in the belt in the event of the metal flowing through the bottom tuyeres. The cupola is coned down above the charge-hole door and is provided with a tank spark-arrester fitted with a special firebrick hood which effectually prevents the depositing of dirt on the roofs of the adjacent buildings.

The charging platform, 30 ft. by 20 ft. by 20 ft. 6 in. high, is self-contained and independent of any building, and has a total storage capacity of 150 tons, or 560 lbs. per square foot of area. The hoist, 5 ft. 6 in. by 3 ft. 6 in, is of the overhead electrically-driven type, having a lifting capacity of 15 cwts. at a high speed, and is operated either from the ground level, the platform, or the cage. The blast is supplied by an L-size improved Roots' blower, electrically-driven

by means of gearing, the speed being under control.

The blast pipes are laid in a trench and enter the cupola by two vertical pipes, one at each side of the air-belt, care being taken to avoid sharp bends. This plant, which has now been at continuous work for over two years satisfactorily, was designed, manufactured, and erected by Messrs. T. Davies & Son, Railway Iron Works, West Gorton, Manchester, who make a speciality of foundry melting plants, and have recently put down special plant for the manufacture of ladles, sand mills, foundry rattlers, and other foundry equipment.

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FOUNDRY CUPOLA CONSTRUCTION.*

By Thomas D. West.

In years back, when one foundry was supposed to make almost everything from stove plate to an anvil block, the one arrangement of a cupola was made to answer all purposes. In other words, it was a jobbing cupola that was not pressed severely by competition. Our great diversity of specialities to-day has brought about such a demand for corresponding differences in cupolas that the wise founder will learn what features he should have in a cupola that it may best meet special conditions.

Cupolas and their Requirements.

We have now in our different classes of foundries conditions that call for :—

1. A cupola that can run steadily and continuously for 12 to 144 hours, or all the week, day and night.
2. A cupola that can run at intervals of one to two hours, but without dropping its bottom for from four to eight hours.
3. A cupola that can melt fair-sized heats of very fine or dirty scap alone or mixed with pig-iron.
4. A cupola to melt steel scrap, tin scrap, or sheet iron mixed with grades of cast-iron scrap or pig-iron.
5. A cupola that will burn out the lining the least.
6. A cupola capable of melting large heats in proportion to capacity most speedily.
7. A cupola that can melt a large heat in the shortest time, or as fast as the metal can be taken away from it.
8. A cupola most economical in its use of fuel.
9. A cupola requiring the least labour in cleaning out and the droppings from which are most free of shot-iron.
10. A cupola that can hold from two to ten tons before being tapped.
11. A cupola from which metal can be taken continuously.
12. A cupola that will give the best "hot" and clean iron.
13. A cupola that can best melt very large scrap.
14. A cupola best adapted to the use of coke or coal or the two mixed.
15. A cupola that can melt a large or medium heat slowly so that its metal can be taken steadily by occasional taps in the lapse of five to nine hours.

All of the above different features involve more or less blending of variations that make a very interesting study in the flexibility of cupola practice. In treating the special points raised, the writer can only cite the main conditions involved, but these should be sufficient to place any one at all conversant with founding in the way of attaining the desired ends.

Construction.

In taking up a brief description of the chief features and combinations required in the construction of cupolas, we will refer in order to the foregoing numbers :—

1. Those that must have the main tuyeres from 3 to 4 ft. above the bottom plate; a slag hole 12 to 18 in. below the bottom of the tuyeres, and two to three rows of tuyeres. The cupola should have a height of 16 to 20 ft. from its bottom plate to the bottom of the charging door, and not less than 60 in. inside diameter; the walls to be generally of a straight character.

2. This calls for a cupola so arranged that all openings below the charging door can be closed to prevent the admission of air at any point. It should have a large breast that can be removed at the end of every period in melting, to take out all iron droppings and slag before banking. This latter holds the incandescent fuel from further burning until all is again ready to charge more fuel and iron and put on the blast. If a warm blast is used the better the success in continuing such intervals of melting. The principle adopted by the Baillot patent cupola is excellent for intermittent melting.

* Read at a meeting of the New England Foundrymen's Association, Boston, Mass.

3. A cupola for this will also serve for No. 4. It should have two rows of tuyeres, the bottom row being from 24 to 36 in. above the bottom plate and having a slag hole 10 to 14 in. below the bottom of the tuyeres. The cupola should be from 36 to 50 in. inside diameter, but if larger than 60 in. a centre blast would be found very advantageous. In height such cupolas should range from 10 to 16 ft.

5. The best of all features for this is centre blast alone or in combination with outside tuyeres, when used in cupolas over 60 in. inside diameter. Without centre blast the lining would need to be brought in at the lower tuyeres, and the latter should have large openings. Upper tuyeres are not used in this cupola for reasons stated later. This cupola should also be sufficiently large in diameter to permit of medium-sized heats and a mild blast.

6. This cupola invariably calls for high tuyeres and a slag hole 8 to 12 in. or more below the bottom of the tuyeres. It is best to have upper tuyeres, and flux should be charged with the fuel and iron to help form a fluid slag that can be run off between taps after the cupola has been melting about 30 minutes. Blast should range from 8 to 12 ozs. pressure and pass through large area tuyeres. Cupolas under 50 in. inside diameter are best with a straight lining; over 60 in. the lining could be brought in or boshed or a centre blast could be used.

7. This must be of a large size for its capacity, have low tuyeres and no slag hole. The tuyeres should be of large area and it is all the better if there is an upper row. With cupolas over 40 in. inside diameter, the tuyeres may well be brought inward or boshed, or if the diameter is over 60 in. a centre blast should be used, the blast pressure to range from 10 to 15 ozs. This is a cupola most desired by shops having a large force of men who pour off as soon as possible. Such cupolas cannot be expected to be the most economical in fuel, but if they can cut down the time of a large force, 15 minutes saved on every heat pays for considerable fuel.

Fuel Economy.

8. In this case we have first to consider that whatever size is used, the cupola will be run to near the limit of its capacity. We have then to figure on a high cupola having tuyeres of large area brought in to work in connection with upper ones, and if over 60 in. inside diameter, to use a centre blast in combination with the outside tuyeres. There must also be a slag hole 6 in. below the tuyeres, and this is to be used after a cupola has run about one-third of its heat. The bottom row of tuyeres should be of fair area and range from 18 to 24 in. in height from the bottom plate. Blast pressure is 8 to 10 ozs. If this cupola cannot be run to its capacity, then lower the tuyeres 6 to 8 in. and dispense with the slag hole. The manipulation of such cupolas has also very much to do with the question, as a founder well versed in his own cupola and having progressive ideas will use much less fuel than one following the opposite policy.

9. Two plans may be adopted for this work. The first is to utilise a cupola after the features embodied in No. 7. The second is to use a centre blast, or fairly high tuyeres of large area, and in all cases where cupolas are to be run over one-half of their capacity to utilise a slag hole to its best efficiency. In no case should any cupola be run over the limit of working in good order if a saving in cleaning out and in shot-iron is an object for consideration above the other points.

10. An ordinary cupola having a slag hole and the height of tuyeres gauged to the greatest amount of metal desired to be held before tapping.

Continuous Pouring.

11. This, as a rule, calls for a cupola larger than necessary for melting the size of the heat required, as with a continuous flow the metal should come down in a stream sufficient to prevent dull iron. As a rule, such cupolas can be worked with low tuyeres, which means greater economy in fuel than having high ones for short heats, and do not require a slag hole. Upper tuyeres could be used here to increase the speed of melting; otherwise they can be omitted.

12. This demands large tuyere areas and in large cupolas bringing the tuyeres in all that is practical, or the use of a centre blast in connection with the outside tuyeres. The bottom of the tuyeres should be from 12 to 16 in. above the bottom plate, and the fuel should be carried up to support the iron as high above the top of the tuyeres as a blast pressure of 10 to 12 ozs. will carry it to best locate the melting point. If a cupola requires to hold large bodies of metal before being tapped or to run long heats for its capacity, then it will be necessary to carry the tuyeres higher and use a slag hole. Upper tuyeres would also be found

serviceable here as an aid to the running of long heats.

13. The ends are best served here for medium heats by having the lower tuyeres from 14 to 18 in. above the bottom plate. The tuyeres should be of medium areas, and the blast pressure range from 12 to 16 ozs. A good pressure is needed for such work, because it is wise to carry a high bed to keep the heavy iron from settling down in dangerous proximity to the lower tuyeres. If the cupola is to run long heats for its rated capacity, the tuyeres should range from 8 to 12 in. higher, and there should be upper tuyeres and a slag hole. The height of the cupola from its bottom plate to the charging door should be of medium range. These cupolas are also best provided with a crane or other appliance by which very heavy bodies of iron can be lowered slowly to the bed. The largest single piece of iron the writer knows of being melted in a cupola was a solid block weighing three tons. This was melted by the Pratt & Whitney Company, Hartford, Conn., U.S.A., in a cupola 40 by 50 in. inside measurement, using all hard coal for fuel.

14. In using coal, lower and smaller tuyeres are utilised than with coke, and if the two are mixed an average should be struck in placing the tuyeres. The rule for slag hole is the same with one as the other, only there is not as much slag coming from hard coal as from coke. Cupolas for coal can be of less height than for coke. Much slower melting may be expected with the former than with the latter.

15. The conditions for this cupola are largely the opposite of those required for No. 7. Here we require a cupola small in proportion to output, with high and large tuyere areas, and a slag hole well below the tuyeres. If the cupola is over 50 in. inside diameter, it is best to bring the tuyeres inward, or if over 60 in. to use a centre blast. The blast pressure, ranging from 4 to 8 ozs., is regulated largely by the fluidity of the metal required. The hotter it is wanted, the higher the bed of fuel needed, and hence higher pressure of blast. Upper tuyeres work well in this cupola.

Cupola Manipulation.

By large tuyere areas we mean having the openings for the admission of blast to the interior of the cupola equal to about 25 per cent. of the area at the melting point. The minimum area for tuyere openings should not be less than 6 per cent. of the area at the melting point. Small tuyeres may in some cases do for melting with all hard coal, but for coke large tuyeres are best.

In reference to the use of upper tuyeres it is to be understood that these create another melting zone. That means the additional burning out of a lining. It is chiefly in the case of running long heats and where a slag hole is necessary that upper tuyeres are most efficient. The disadvantage of the extra burning out of the lining is often so serious that whatever advantages may be gained have but little weight.

The function of upper tuyeres is to deliver needed oxygen to the escaping carbon monoxide, thereby preventing a loss of heat. As far as this is concerned, the principle is correct, and any who take advantage of it without being too seriously handicapped by the extra burning out of a lining, will find that upper tuyeres save fuel and permit a cupola to run long heats with less "bunging up" than otherwise. It is generally best to have upper tuyeres built in a cupola, and when not found of advantage they may be easily stopped up with valves and clay.

Where reference is made to a slag hole, it is to be kept in mind that the greater the distance between the slag hole and the under side of the bottom of the tuyeres within limits, the better for running long heats or melting down fine or dirty stock. Having a slag hole implies the use of limestone or other flux to create a fluid slag.

The blast pressure given with the forms for construction is to be understood as applying to coke. Where hard coal is used, the pressure will need to be from 4 to 8 ozs. higher.

Centre Blast.

Although the writer has used centre blast most successfully for over six years and strongly recommends it for general use in large cupolas, he does not expect many to adopt it on account of a fear most foundrymen seem to have that it will cause them trouble.

Those who are too timid to try centre blast may have recourse to a design exhibited by John C. Knoeppel at the Convention in Toronto. This form of a cupola has ample tuyere area and can be brought inward or boshed for large cupolas and made to meet other conditions referred to above. Wherever a centre blast is used in connection with outside tuyeres, the lining of the cupola

is to be kept straight, as the centre blast makes it unnecessary to bring the outside tuyeres inward beyond the face of the lining to form a bosh.

One notable advantage of a centre blast lies in permitting the use of a mild blast. The oxygen of the air and not pressure is what the fuel demands to cause combustion. We use pressure merely to force the oxygen in the air to the exterior and central portions of the fuel body. The greater this pressure the more cooling and "bunging-up" effect it has on the body of stock facing the tuyeres when using cold blast. We can continue this cooling effect until a cupola is completely "bunged up." Could we but have a hot blast as convenient as a cold blast, many of the difficulties encountered by founders in having bunged tuyeres and bad melting would be avoided. This point was well demonstrated by the Baillot cupola at the last Convention of the American Foundrymen's Association by the manner in which it could be banked and restarted to melt down iron at intervals.

Something besides the mere cupola is to be considered in securing its best efficiency for different conditions. Any one contemplating the purchase of a cupola should know what is to be required of it, and then see that it has a combination of the features that are best for the special conditions. After erecting a cupola, of course, a great deal depends upon its manipulation, but the best operator cannot make up for the lack of a construction meeting the special purpose for which the cupola is to be used.

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MESSRS. DUCK & WOOD, manufacturing engineers, etc., have established new premises at 47, London Road, Croydon.

GAGGERING.

THERE are many ways of taking care of deep lifts, or the hanging parts of a mould. In some foundries it is the practice to use for green-sand "soldiers," which are 1 in. square pieces of wood from 4 in. to 14 in. long, of which a stock is kept. They can be cut up from any old pieces, are cheap, and in places where the castings are shaken out soon after pouring there is not much waste. The use of "soldiers" must be limited to boxes or flasks that have bars in, so that at least a third of their length can be gripped tightly by the last course of sand. This also applies to the gagger shown in Fig. 2, which is made of $\frac{3}{8}$ in. or $\frac{1}{2}$ in. square or round iron. The lifter shown in Fig. 1 is very useful both for dry and green sand, as the hook on the upper end makes it safe. It can be used in making a drag or bottom part do service as a top part or cope, should there be many flanges or projections on the top half of pattern, thereby saving the expense of making boxes. The gaggers shown in Figs. 1 and 2 can be made in cast iron, a number of patterns being placed on a board and stamped out on a bed, or a water-cooled chill could be devised and someone told off to keep up the supply. To all the foregoing methods the objection can be made that their lifting capacity is not in proportion to the room they occupy, it being often difficult to ram the job properly, and should there be pieces on the pattern that must be loosened, and perhaps blacked and finished, to be afterwards drawn into the mould or covered with a cake, the "soldiers," gaggers, etc., are apt to be in the way. For green sand work the plates and crosses shown in Figs. 3 and 4 are very useful. Fig. 3 is a plate 6 in. by $1\frac{1}{4}$ in. by $\frac{1}{8}$ in. or $\frac{5}{16}$ in. thick, with

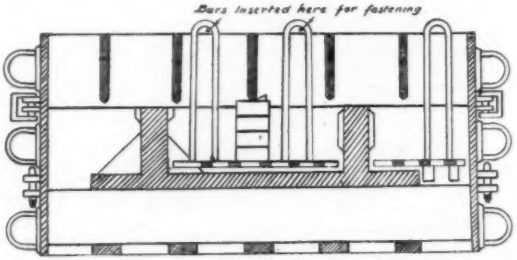

FIG. 6

GAGGERING.

a stem of ¼ in. round iron rivetted in the centre. Fig. 4 is made of ⅜ in. square iron welded as shown, with ¼ in. round iron stem. The top ends of the stems are flattened out for about 3 in. The plates are used for joints only, the crosses being used on the casting. The flat ends are bent over the sides or the bars of the box after ramming up. The objections urged against "soldiers" and gaggers cannot be used against the plates and crosses, as they occupy very little room compared to their lifting capacity, and in combination with a stock of boxes in which the top parts are made with flat bars similar to the bottom parts they make a very elastic arrangement. For dry sand work

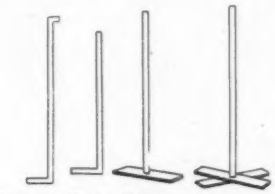

FIG. 1. FIG 2 FIG. 3. FIG. 4.

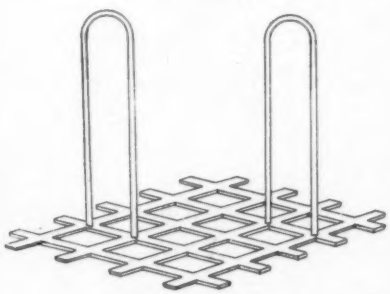

FIG. 5.

GAGGERING.

the arrangement shown in Fig. 6 is very useful, as by the use of gratings and a mid-part as shown, the whole of the pattern can be rammed up and all screws, nails, wires, etc., taken out from washers, bosses, or any projection. The mould can be blacked, finished and caked, and vents, etc., can be arranged with the greatest freedom before the top part is placed on for the final ramming. Gratings can be used to take care of any lifts where no mid-part is used, as they can be placed in position and rammed up to joint level before the top part is put on. They are easily fastened with a short bar reaching across the box bars and made tight with a wedge after the final ramming.

It is sometimes necessary to pack with bricks from the grating to the top part, as shown, to stiffen while turning over. The gratings are not very expensive to make, as they can be stamped out on a bed. The lifting hooks can be made of a diameter suitable to the load they have to carry. If the smith is told to cut one leg the right length and to make the other 6 in. longer, merely nicking at the proper length, the long end can be stuck in the bed to the depth so that they will need no other support while casting, and the projecting end can be knocked off after casting. Fig. 5 is another view of the grating shown in the centre of Fig. 6. The grating over the flange on the side has prickers-on to take care of the joint.

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MELTING IRON IN SMALL QUANTITIES.

By W. R.

It is well known that iron foundries, as a rule, only cast in the afternoons, so that any small casting cannot be had until the evening of the same day. Iron taking much longer to cool than brass, it is at times good practice to cast small work in brass, and thereby produce work that is urgently wanted in the shortest possible time. If this is objected to, however, it must be cast in iron, and the crucible used to melt the iron. Small cupolas are sometimes used for experimental work, and melting for breakdowns or repair work; but it must not be forgotten that the smaller the cupola is, the cost of melting becomes considerably increased as compared with the larger ones. In order to prove this a cupola was recently prepared in the usual way, and had a bed of 18 in. of coke above the tuyeres. The total weight of iron melted was 4 cwts. The charging of this cupola, which, by the way, was only 12 in. diameter, with a depth between tuyeres and bottom (or hearth) of about 9 in., could not be an ideal job for a cupola man.

Procedure of charging is reported thus: "100 lbs. of scrap was melted in 20 minutes from the time the blast was turned on. The blast was then allowed to continue for some time to make sure that all the iron was melted. The bed was next made up the proper height once more and charged in the following manner: 50 lbs. pig-iron was placed on the bed, 20 lbs. of coke added, and 50 lbs. of iron placed on the top of it. The

second charge was then covered up with a siddle full of coke, which just filled the cupola. These operations were repeated for each succeeding lots of iron melted, the blast being allowed to blow for a little while after each charge, so as to ensure all of the iron being melted out of the cupola."

The time recorded, apart from expense, with this somewhat experimental cast will doubtless surprise those that are best fitted to judge, not to mention the quality of the iron thus melted, and as a test of pig-iron was the object reported of the cast in question, nothing in the form of a reliable test could be possible under such conditions of melting. Cast iron is far too susceptible to change to admit of such casts as here reported being reliable. Intermittent charging, and intermittent blowing is bad for everything in the form of castings, whether of castings for engineering purposes or test bars, where the best practices possible become imperative.

Without going into details of what the smallest cupolas should be to work at a profit, it ought to be said that the fitting of a cupola which can only cast 10 or 15 cwts. at a melt, is, in a sense, as costly as one that is capable of casting tons for the cwts. mentioned. Therefore a cupola 12 in. diameter and only 9 in. from the bottom of hearth to the bottom of tuyere, is too costly a "pot" to use in the melting of either 100 lbs. of scrap or pig-iron. As a matter of fact, if 100 lbs. be the maximum charge with such cupolas, anyone is safe to say that such charges would not be repeated often before "bridging" or "bunging" became an accomplished fact.

So far, it would appear that small cupolas that are kindled merely to melt 100 lbs. or 200 lbs. of iron in a hurry must be money wasters. Hence, where crucible melting is in practice, the crucible should also be used for the small quantities of iron. It must be borne in mind, however, that the highest melting point of brass is in the region of 1,100 degrees C., which is 400 degrees below the melting point of iron. The melting point of steel is 25 per cent. more than iron, and the crucible that is made to melt either steel or brass will more than endure the fire that is needed for the melting of iron.

It was the writer's duty to attend to all matters of despatch in the way of casting in a foundry doing a good lot of heavy and light castings in brass and iron, both standard and jobbing. This being so, breakdowns had often to be attended to, and for work of the smaller grade the small cupola was often brought to play, even for as little as 1 or 2 cwts., notwithstanding the melting capacity of this cupola was normally 2 tons. Irrespective of cost, push became the order of the day, and not until the price of those castings was taken into account did there seem to be anything wrong. But, ultimately, this extravagant waste of time, money, and material was ended, and such work was all done in the brass foundry. Concerns which do their own brass castings are quite able to do iron ones as well, so long as they are within the melting capacity of the crucibles in use. If the practice thus commended be once begun, it will not be ended in a hurry, as metals cast from crucibles are superior to those of any other process.

It is strange that crucible steel founding has been so long in operation, and crucible cast iron is but in comparative embryo commercially. Of course, cost of production means much, but for small work it is a matter for serious consideration as to whether crucible castings can not be produced at a more reasonable rate than those cast from a cupola. The engineer, although he paid a higher rate for his castings of crucibles melt, would have the advantage of the easier finish and superior quality.

Crucible iron founding may be classed as a speciality, and a special section of pig-iron would be necessary, so that the breaking for melting in the crucibles would be easy. The orthodox section of grey pig-iron is not suited for charging the crucible; but there is no reason why pig-iron should not be cast 2½ in. by 2 in. in section.

Lastly, if test bars in cast iron be wanted, do not trust to metal that is melted by intermittent blowing and melting. Cast such bars, if possible, with the crucible, as well as all other castings in iron requiring only a small quantity of metal.

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THE new engineering laboratories at the Heriot-Watt College, Edinburgh, consisting of a number of large halls in a newly-erected wing at the back of the College, were formally opened last month by Lord Rosebery. The total floor area covered is over 12,000 square feet, apportioned as follows: — Wood workshop, 1,450 square feet; engineering workshop, 1,700 square feet; engineering laboratory, 4,400 square feet; applied mechanics laboratory, 2,000 square feet; strength of materials laboratory, 1,360 square feet; smithy, 740 square feet; motor pit, 375 square feet.

QUALITY V. QUANTITY.*

By J. N. Gamble.

In the beginning of this article, let me say that it is my intention to strive to show that the improvement in quality and increase in quantity must go hand in hand to insure success.

No job is well done because you take ten hours to do what ought to have been done in five, and it is certainly just as true that a foundry running 25 per cent. less than its capacity may be making the poorest possible castings, while the one running to its utmost may be making the best. But the question is, "How"?

1. Men. 2. Metal mixtures. 3. Machinery. 4. Moulds. 5. Cores.

Some time ago, I heard it stated that all a foundry needs as moulders and machine operators are men with strong backs and weak minds. If any of you have this idea you had better throw it into the scrap pile along with the poor castings such practice will produce. There never was a time when we needed more intelligent workmen than we do at present. All factories are looking for successful managers, but many overlook the man with the overalls.

While much has been accomplished by installing machinery to do many kinds of work, it is still a fact that without intelligent and sober workmen, first-class work cannot be done with the best possible machinery; while, on the other hand, it is wonderful to see the good work that can be produced with poor equipment by intelligent and sober men. In fact, the question of brains extends even down to the man shovelling sand. If your core sand is not properly mixed, the whole casting will be *scrap*; if your moulding sand is not properly tempered the result is *scrap*; if moulds are carelessly made, again the result is *scrap*; if your metals are not mixed in the right proportions for the particular work you are making and brought up to the proper temperature, once more you will have *scrap*, and the scrap pile is the loss account.

Let us look at some of the qualities needed in our employés. First, the foreman must be a man of such character that he will have the respect of his men, and must also have a thorough knowledge of brass foundry practice from core-making through to finished casting. Further, he must see all things going on at all times and have perfect control of the foundry.

Now let us look at some of the workmen—here is a boy setting cores. Watch him, for he is some day to be a moulder or machine operator; is he quick and accurate, or slow and careless? If he has the first qualities, keep him and teach him from day to day how to work and you will receive large returns in both quality and quantity of castings. If he has the second qualities and you cannot get him interested enough in his work to change his ways, drop him, or your scrap pile will increase, your quality deteriorate, and your quantity diminish. Notice this machine operator—he is putting up a large number of moulds, but if you examine them, you will find the mould broken in the sharp corners; examine his pattern, and you will find it has not been brushed off for some time, so while his output in flasks is large, the actual production of good castings is small. But here is an operator working next him who is putting up as many moulds, and they are all clean and corners perfect. Take the castings from this man's floor and you will find the output of good castings much more than the others, and the general appearance much better. What is true of machine work is just as true of floor or shop bench work. It is the intelligent use of brains that counts for or against the successful operation of a brass foundry.

Now your moulds are closed and you can watch the pouring. Here comes the crucible, and you notice after they have poured a few moulds that the metal is cold and stringy, but they pour it all into moulds; result, "cold shut," "misruns," and "unsound castings," more added to the scrap pile. This shows that the melter is not making an intelligent study of his work.

Before leaving this question, let me say that we must give our employés careful instruction in their duties if we expect them to give us the best work. They should also be shown the result of careless work. A good plan is to post a list of scrap made, with the name of the operator making the same. This has been tried with good results.

After securing men with brains in all departments of your foundry work comes the important question of metal mixtures. It is not my purpose to give you formulæ for metal mixtures, as each different class of work calls for its own peculiar percentage of the various metals to give to it the peculiar qualities needed.

One thing, however, is sure; you cannot put poor metals into crucible or furnace and expect to produce a high grade

* Read before the American Brass Founders' Association.

of castings, and it is just as sure that you can put in good metals and make scrap. Everything that goes into the mixture should be as free from dirt and all foreign substance as possible. The use of gates and sprues without cleaning is bad practice. In fact, the importance of a proper mixture of metals cannot be too strongly emphasised, for if your metals are properly mixed and melted, a large part of your troubles are over.

Shall we use crucibles or melt in open furnace? I have seen poor melting in crucibles and good in open furnace; and then again good in crucibles and poor in open furnace. A good deal depends on the proper handling of either. One thing is sure; we should protect the metal all we can from oxidation while melting to obtain castings free from defects. I believe every brass foundry should have an analysis of its castings each day to determine whether the mixture is correct. We should also have test bars for determining the tensile strength, as only by this means will we know for a certainty that our product is up to standard.

Now as to machinery, some say that you cannot make good castings on power moulding machines; others contend that all castings can be made better on machines than by hand. I agree with neither, but believe that we should use power machines where they are an advantage; but these machines must be as simple as possible, free from complicated bearings, as nothing destroys like fine dust and sand. Wonderful improvements have been made in moulding machines in recent years, and none of us are now prepared to say you cannot make this or that on a machine. I myself have seen fully as good castings made by machinery as by hand, and have also seen some of the poorest castings made with machines. This leads me to say that if you have a large number of duplicate castings to make, look into the power machine; buy the best machine for your men to use. If, on the other hand, you are doing a jobbing business, and have a few pieces to make from each pattern, you will need to investigate very carefully before installing the power machine. The power machine is a great quantity producer, and I believe if properly made and operated by intelligent men will produce castings that will satisfy your most particular trade.

The moulding sand must be properly mixed and tempered, for if your sand is too wet you will have a "blow." Then the sand must be properly rammed into the flask; for if it is too hard in spots, you will have a "blow"; if too soft, the metal will cut. In fact, from the wheeling of sand into the shop to the placing of a perfect mould on the floor, the work must be done intelligently.

Now as to cores, some foundrymen seem to think they can take several kinds of sand and a little resin, or some of the various compounds, mix them together and get good results. It is necessary to have first-class cores, for a poor core is nearly certain to give you a scrap casting, or one very rough in appearance. What we should do is to secure by careful tests that core mixture which gives the best results for our particular line; cores that are first-class for some grades of castings will not answer at all for others.

Nothing has been said so far regarding the pattern. Ask the pattern-maker and he will say that the patterns are always made right. But are they? Is it not a fact that the foundry foreman often has to try to make good castings from a pattern not properly drafted, or else constructed so as to make it very difficult to make a good clean casting. Both the pattern-maker and draftsman should consult the foundry foreman, as he is in position to give some valuable hints as to draft, gating, etc., to obtain the best results.

In fact, with the tendency to higher steam pressure and faster speeds of all machinery, it needs the careful study of trained men if we expect to improve the quality of our goods, and at the same time keep up the output to the maximum.

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Black Spots on Brass Castings. — Casters of yellow brass are sometimes troubled with the appearance on the casting, after they are dipped, of dark spots. Often a good deal of care and attention is expended on the selection of the metal without the difficulty being overcome. These spots are ordinarily of a dark brown colour and caused through the presence of iron in the scrap metal. In such cases the iron oxide spots can be dissolved off the casting by using a diluted pickling bath of hydrochloric acid, or a mixture of hydrochloric and nitric acids. The concentrated acid should be diluted with about three parts water to one part acid. Spots may also result from improper rinsing of the castings after dipping. They should be thoroughly rinsed in hot water after dipping in the ordinary dipping solution, and then allowed to dry. It is also advisable to keep the lead in the mixture as low as possible.

The "Foundry Trade Journal" Bookshelf.

Modern Foundry Practice.

By John Sharp.

In endeavouring to place in order all the most useful of the available information concerning foundry work, the author has compiled a work which defies an adequate summary in the space we have available. Briefly, the book treats with green-sand, dry-sand, and loam moulding, the materials used, descriptions of the machinery and appliances employed, and practical examples and rules for foundry practice. To those at all familiar with foundry literature this book requires no eulogy, for it is well established amongst the best of foundry works. Starting with the subject of pig-iron, the author considers its characteristic mixtures, its elements, composition, and particular properties. The next chapter is devoted to some points to be observed in designing castings, with especial reference to the crystalline formation of metals. Fuels and the methods of their production are well dealt with, and illustrations of various coke ovens and gas producers are given. Coming to the question of furnaces for remelting, the author deals somewhat extensively with different designs of cupolas, their working and management, following with an interesting chapter on reverberatory or air furnaces. Then follows a more technical treatise on temperatures, measures of heat, thermometers and pyrometers. Refractory materials and crucibles come in for consideration, and then the author deals with blast, blowing engines, fans and blowers, various apparatus being fully described.

Passing then to the pattern-making department, a chapter is devoted to the most suitable woods for different work, the treatment and preparation of patterns, and pattern-makers' tools. Then come the materials used in moulding, their preparation, mixing and finishing, the apparatus employed in the preparation of the materials being also described and illustrated. This section of the book also deals with hay and straw ropes, moulding boxes and flasks, moulders' tools, the effects of cooling and contraction, core irons and core bars, core-making and venting, and so on through the whole of the moulder's equipment and paraphernalia. These having been described, the art of moulding comes in for fuller treatment. Plate moulding and moulding machines follow, and are dealt with to a considerable extent. Then come under consideration the subjects of chill casting, malleable cast-iron, case-hardening, and the apparatus employed. A short chapter is also devoted to the subject of casting on to other metals. Foundry drying stoves, their arrangement and firing, foundry pits, and foundry ladles are other matters treated, and a good many pages are devoted to cranes. Cast steel is too big a subject to be dealt with to any extent in the book, so the author confines his attention to describing chiefly the production of steel castings from crucibles. Brass founding and brass melting furnaces receive attention in one chapter, while others are devoted to the subjects of bronze fine-art work and bell founding. Apparatus for cleaning and dressing castings naturally receive attention, and the book is concluded with the subject of costs of moulding and casting, a chapter on alloys, and a collection of useful tables and notes.

As will be seen from the foregoing, the ground covered is very extensive; in fact, there is no department of foundry work which is not considered. Many of the subjects, of course, would bear much fuller treatment, but bearing in mind that a book of this description has necessarily several limitations in regard to the length at which each topic may be dealt with, it will be conceded that it is a very valuable addition to foundry literature.

The publishers are :—Messrs. E. & F. N. Spon, Limited, Haymarket, W.C.

Steel Casting.

We have before us an enquiry from a correspondent for a book dealing exclusively with steel castings, but an examination of the books we have by us does not reveal any such work. Enquiries at the various publishers of scientific and technical works also are fruitless, so we can only refer our correspondent to such books as include the subject in their contents. Various authors writing on foundry matters have devoted a few chapters to the subject of cast steel, but nothing like the same attention has been given to it as has been paid to ironfounding. Perhaps the work which treats steel casting most fully is "General Foundry Practice," by A. Mc.William and Percy Longmuir, *Charles Griffin & Company, Limited.* [Ed. F. T. J.]

DEOXIDISERS AS A METHOD OF PREVENTING BLOWHOLES IN STEEL CASTING.

It is necessary when making steel by an oxidising process (such as the Siemens' open-hearth, etc.) to add sufficient alloys to it to obtain a fixed type of metal (casting or ingot) free from all internal defects, excepting the contraction difference between solid and molten steel (which in all cases is 12½ per cent. of its mass). This condition is always definite, and if absolutely pure steel is taken as 100, then the minimum type which can be made free from defects (excepting the contraction difference) is 166. For instance, no steel, after boiling under an oxidising slag, can be free from blowholes, or similar defects, if its type of quantities of alloys is under 166, pure steel being taken as 100.

The following is the relative value of the various elements usually used for "killing" steel: — Manganese, 1.00; silicon, 5.25; aluminium, 87.00. No steel will lie quiet in the mould if it contains less than 1.66 per cent. of manganese, other alloys being absent. This percentage must be present in the steel. It would not be sufficient to add 1.66 per cent. of manganese, as a loss in addition takes place, so that the resulting steel would be below 1.66 per cent. manganese, and would not be sound. This condition also means that this is the minimum amount of manganese required when all other alloys are absent, and similarly: —

For silicon $\frac{1.66}{5.25}$ = say 0.32% silicon.

For aluminium $\frac{1.66}{87}$ = 0.02% aluminium.

and these are the minimum amounts.

Now, aluminium is extensively used as a deoxidiser on account of its high relative value, but its use alone has many serious objections, which are realised by only comparatively few steel makers. Although the relative theoretical value of aluminium is 87, when used alone, only 8 per cent. of the quantity used actually enters the steel, as owing to the great difference in melting points between aluminium and steel, volatilisation of the Al. takes place. To overcome this to some extent, aluminium has been used alloyed with another metal, but this double alloy is not a perfect flux to form slag, and hence is not sufficiently efficient. The ideal deoxidiser is a triple alloy of silicon, aluminium, and manganese, which has a very high efficiency, and is a perfect flux. In the triple silicon-aluminium-manganese alloy, known as "S.A.M." alloy, 50 per cent. of the aluminium is available for deoxidising, as against 8 per cent. only when aluminium alone is used. In "S.A.M." alloy—

$$(Si \times 5.25) + Mn + (Al \times 87) = 553.5.$$

and $\frac{166}{553.5}$ = say 0.30

so that theoretically the addition of 0.30 per cent. of the alloy would completely deoxidise open-hearth steel; but as only 50 per cent. of the aluminium is available, 0.60 per cent. "S.A.M." is necessary.

The melting point of this alloy is extremely low, and therefore it can be added to the ladle without any chilling of the melt being evident. For the above reasons the triple alloy "S.A.M." is much better than virgin mixtures of the three constituents, and gives results which cannot be obtained by the use of aluminium, ferro-manganese, ferro-silicon, or manganese-silicon, used either alone or together.

The above applies to all steel which has undergone boiling under an oxidising slag in manufacture, and containing all percentages of carbon up to 0.89 per cent.; consequently, as crucible steel is often above 0.89 per cent. carbon, it does not apply to that class of steel. For steels above 0.89 per cent. carbon rather less of the aluminium is volatilised, as the steel melting point is lower, and consequently less "S.A.M." will do the work.

An interesting booklet entitled "Solid Ingots and Castings," describing this alloy, is issued by Messrs. Geo. G. Blackwell, Sons & Company, Limited, Liverpool.

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A Flux for Melting Brass.—A new flux for melting chips, washings and scrap of all kinds has been invented by Mr. T. Callow, proprietor of the Newcastle Smelting and Refining Works, of London. It is composed of the following: —

Chalk	1 lb.
Fluorspar	1 lb.
Glass	½ lb.
Borax	1½ oz.
Coal-dust	4 ozs.

The flux, he says, is equally applicable to the smelting of white metal drosses as it is for copper alloys.

LIST OF NEW INVENTIONS.

Specially compiled for the FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, 77, Colmore Row, BIRMINGHAM.

APPLICATIONS.

Sept.-Oct., 1908.

19,314. A. BERNARD, and L. SANNA. Improvements in apparatus for treating fine mineral matters.

19,882. H. R. ANGEL. Improvements in the treatment and reduction of complex sulphide and other ores.

20,407. C. A. PIM and F. E. MATTHEWS. Improvements in the manufacture of steel.

20,500. A. REYNOLDS. Improvements in the manufacture of steel.

20,788. J. F. MONNOT. Improvements relating to the production of metal ingots or other bodies.

20,902. W. G. WILLIAMS. Improvements in means for extracting metals from their ores, also applicable for heating, melting, or volatilising other substances or materials.

21,041. A. WELCH. Improvements connected with the casting of pipe bends.

21,232. J. D. TOPHAM. Improvements in foundry and other moulding machines to be operated by hand or otherwise.

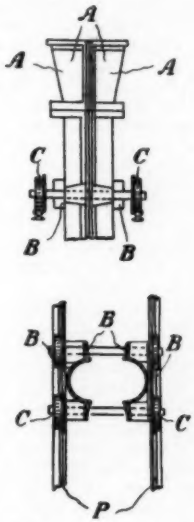
1907.

26,390. F. HERBERT, Durham. Improvements in foundry plant for the vertical moulding and casting of pipes.

According to this invention the pipe boxes are secured on bogies or on axles and wheels in such a way that the pipe box extends downwards below the level of the rails on which the wheels run, and in addition the pipe moulding boxes and the bodies or axles and wheels by which they are carried are formed in such a way that two or more parts of a box remain always upheld in a vertical position of the bogies or axles and wheels whether the mould be opened or closed. The rails on which the wheels run are carried on pillars; the platforms on which the workmen stand when handling the boxes may also be carried by the pillars or supports.

Small sized boxes may be made in two longitudinal halves capable of being slid towards and away from one another along the axles of the wheels; the two axles might in this case have cotter holes formed in them so that they may serve both as axles and cotter bolts.

As shown in the illustration, A is the pipe mould in use on the track, B, the



boxes adjustable along the axles of the wheels, C, the wheels of the trolley running along the rails D.

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CORRESPONDENCE.

Foundry Classes.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Concerning practical foundry classes, I may say that in Bootle, a borough adjoining Liverpool, a class has been held in the evening technical schools during the past six or seven years on this subject, and during this time instruction in moulding and casting has been given to students of various branches in the engineering trade.

A syllabus is drawn up, and although not strictly adhered to, various examples in moulding are done, from the making of a simple square test bar, to more in-

tricate work which involves the principles of moulding to a higher degree.

Included in the equipment of this class is a brass-melting furnace, also a small cupola, with blast supply motor-driven, whereby metal is produced by actual workshop methods, although on a small scale.

I am sorry to state that up to the present, those directly engaged in the foundry branches, *i.e.*, moulders and pattern-makers, have not taken full advantage of this class, consequently the work done is chiefly of an elementary character, although instruction to each student is in a measure dependent upon his personal knowledge of foundry matters.

The objects of these classes being educational, the resultant amount of work produced is generally not large, but as all foundrymen will agree, more lessons are learned from the "wasters" than the good castings.

Should those more deeply interested in foundry matters attend such a class, experimental work could be taken up, material tested, etc., and much valuable information relating to mixtures and alloys be obtained.

I may say that there is in the day school a trade preparatory course for boys aged 12 to 16 years. Moulding exercises are done by them, and much individual thought and ingenuity shown. Should your correspondent "W. R." wish any further information, I shall be pleased to furnish him with same, either directly or through the medium of your journal.

Yours, etc.

"W. R. W."

REPLIES.

Gas Furnace for Copper.

A suitable gas-fired furnace for melting copper, etc., is the "Empire" furnace, the tilting variety of which was described in our issue of November, 1906. The makers are Messrs. Alldays & Onions, Pneumatic Engineering Company, Limited, Birmingham.

Nickel and Copper.

A special oil-fired furnace has been designed by Messrs. Alldays & Onions, Pneumatic Engineering Company, Limited, for melting nickel, and the time required for melting has thereby been greatly reduced. This should be of interest to our correspondent "Nickel."

TRADE TALK.

Mr. S. Spinks has established himself in business at 53, High Street, Arbroath, as an engineer.

Messrs. J. H. Jones and G. Burgess, engineers, etc., Port Talbot, Glamorgan, have dissolved partnership.

Mr. A. Bell has started business as a consulting engineer at Bank Buildings, 60, Castle Street, Liverpool.

Messrs. Patterson & Service have started business as consulting engineers, at 38, Bath Street, Glasgow.

A dissolution of partnership is notified in connection with Messrs. J. Ellison and W. Ellison, ironfounders, etc., Skipton.

The Queen's Ferry Works of Willans & Robinson, Limited, were offered for sale by auction on September 16, but were not sold.

A fire broke out recently at the works of Messrs. Morton Son & Lock, ironfounders, Louth, but the damage was not heavy.

Alfred Herbert, Limited, have been awarded the Grand Prix for their machine tools exhibited at the Franco-British Exhibition.

Messrs. A. W. Davies and G. E. Kemp, engineers, etc., trading under the style of Davies & Company, Abergavenny, Mon., have dissolved partnership.

The "Petter" oil engines of J. B. Petter & Sons, Limited, have been awarded the silver medal for the best oil engine exhibited at the Toulouse Exhibition.

Hodgson & Stead, Limited, of the Egerton Iron Works, Salford, Manchester, have established a London office at 35, Cannon Street, E.C., under the charge of Mr. C. Hodgson.

Messrs. H. L. Taverner and A. F. Lawson, engineers, etc., Leadenhall Street, E.C., trading under the style of Taverner, Lawson & Company, have dissolved partnership.

A dissolution of partnership is notified in connection with Messrs. E. Burgess and A. D. Powell, engineers, Leicester, who traded under the style of the Burgess Engineering Company.

John Tinsley, Limited, of Darlington, makers of steam and electric haulage gears, have appointed Mr. G. Widowfield, of Penarth, Glamorganshire, as their sole representative in South Wales.

Mr. R. M. Neilson has severed his connection with Richardsons, Westgarth &

Company, Limited, and has started business as a consulting engineer and patent agent at 45, Hope Street, Glasgow.

THE option taken by Messrs. Cammell, Laird & Company on land at the Burrows, Swansea, having now definitely lapsed, the idea of establishing works in Swansea or South Wales is abandoned.

THE ASTER ENGINEERING COMPANY, LIMITED, have removed their office staff from 4, Princes Street, Hanover Square, London, W., to their new offices situated at their works at Wembley, Middlesex.

MR. W. K. MELDRUM, late works' manager for Meldrum Bros., Limited, at their works, Timperley, has joined Ed. Bennis & Company, Limited, and becomes their representative for the North-East Coast.

MR. M. P. FORD, of 2, Mulberry Street, Hulme, Manchester, has resigned the managing directorship of the Brooke Tool Manufacturing Company, Limited, and has joined Mr. S. N. Brayshaw, of Manchester, in business.

MR. GEORG FISCHER, of Schaffhausen, Switzerland, has built an electric steel works for the manufacture from the Heroult electric steel smelting furnace of castings up to one ton in weight, for motor car and other work.

MESSRS. CHARLESWORTH PEEBLES & COMPANY, engineers and manufacturers' agents, of 53, Bothwell Street, Glasgow, have been appointed agents in Scotland for Fielding & Platt, Limited, of Gloucester, for the sale of gas engines, oil engines, and suction gas producers only.

IN connection with the failure of Meldrum Brothers, Limited, the Official Receiver in London reports that the accounts show total liabilities, £44,000, of which £21,764 are stated to be unsecured, and a surplus is claimed of £9,605. With regard to the shareholders, a deficiency of £114,611 is disclosed.

PETER HOOKER, LIMITED, have acquired the entire plant, patents, goodwill, etc., of the Newall Engineering Company, Limited, and propose to continue the business as a department of their own business under the name of the Newall Engineering Company at their works, Blackhorse Lane, Walthamstow, London, E.

THE ALUMINIUM CORPORATION, LIMITED, 54, Parliament Street, Westminster, S.W., with smelting works at Wallsend-on-Tyne, and Dolgarrog, North Wales, have appointed Rd. Johnson, Clapham & Morris, Limited, of 24 and 26, Lever Street, Piccadilly, Manchester, as their agents in Lancashire, Yorkshire, Cheshire, Derbyshire, and North Wales for the sale of aluminium products.

MR. H. S. HODGE, for 11 years manager of the Bristol branch of the Gandy Belt Manufacturing Company, Limited, has entered into partnership with Mr. H. I. Jacques, A.M.I C.E., who has represented the Carborundum Company and Applebys, Limited, for some years past in the West of England. They have taken premises at 86, Victoria Street, Bristol, and trade under the style of Hodge, Jacques & Company. In addition to the ordinary lines of engineers and mill supplies, the company have concluded sole agencies for the Carborundum Company; John Ormerod & Sons, Limited, of Castleton; the American Mill Supplies Company; John Taylor & Sons, Limited, Waterfoot, and the Nicholas Walker Raw Hide Company of Shipley.

A MEETING of the creditors of Watts Brothers, Limited, engineers and iron-founders, Packmore Works, Warwick, which is in voluntary liquidation, was held at Birmingham, recently. The statement of affairs was as follows:—Liabilities: Unsecured creditors—trade creditors £2,821 8s. 4d., bank (guaranteed) £857 11s. 7d.; preferential creditors—deducted contra £52 5s. 10d.; loans on debenture bonds with interest accrued to date, deducted contra, £503 8s.; expected to rank for dividend, £3,678 19s. 11d. Assets: £3,394 8s. 3d.; deduct preferential creditors, £52 5s. 10d.—£3,342 2s. 5d.; deduct loans on debenture bonds as per contra, £503 8s., leaving £2,838 14s. 5d.; estimated deficiency subject to costs of realisation, £840 5s. 6d. The creditors decided to leave the matters in the hands of the liquidator.

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MR. G GILKES, of Gilbert Gilkes & Company, Limited, turbine manufacturers, Kendal, has been elected an Alderman of the Corporation.

MR. F. H. KIRK, director and secretary of Samuel Osborn & Company, Limited, Clyde Steel Works, Sheffield, has been elected an Associate of the Chartered Institute of Secretaries.

MESSRS. MAREYAT & PLACE, engineers, 28, Hatton Garden, London, E.C., have taken over the business carried on by Messrs. Joseph Richmond & Company, engineers, etc., of 30, Kirby Street, E.C., and the New Sun Iron Works, Bow, E.

DEATHS.

MR. J. R. SEWELL, of Messrs, Sewell Bros., Well Lane Foundry, Halifax, aged 41 years.

MR. J. S. DRONSFIELD, of Messrs. Dronsfield Bros., engineers, Atlas Works, Oldham.

MR. E. BUSH, of Messrs. Bush & De Soyres, boilermakers, St. Philip's, Bristol, aged 88 years.

MR. C. W. DAVIS, one of the managing directors of the Davis Gas Stove Company, Limited, aged 66 years.

MR. J. C. NICHOLSON, head of the J. C. Nicholson Tool Company, of Newcastle-on-Tyne, at the age of 49 years.

MR. W. H. DAWES, the only remaining partner of Messrs. Dawes & Sons, Bromford Iron Works, West Bromwich.

SIR JOSEPH LEIGH, vice-chairman of the Vulcan Boiler and General Insurance Company, Limited, at 67 years of age.

MR. G. F. FLETCHER, for the last 32 years connected with W. G. Bagnall, Limited, engineers, of Stafford, aged 52 years.

MR. J. GOODWIN, of Motherwell, who founded the business now carried on by the Brandon Bridge Building and Engineering Company.

M. GUSTAVE CANET the eminent French Artillerist, and President of the Junior Institution of Engineers, at La Tourelle, St. Aubin-sur-Mer, France, on October 8 last.

MR. A. SWIFT, of Messrs. George Swift & Sons, engineers and machine-tool makers, of Claremount, Halifax. The deceased gentleman was only 23 years of age.

MR. G. K. STOTHERT, second son of the late Mr. John Stothert, senior partner of the late engineering firm of Stothert, Slaughter & Company, Bristol, aged 75 years of age.

MR. S. MASTERMAN, for 14 years assistant secretary of the Friendly Society of Ironfounders, and a well-known figure in the Trade Union world. He was recently elected general secretary to the Society, and was to have entered on his new duties this month.

MR. S. G. HOMFRAY, who was connected with the firm of Sir W. G. Armstrong, Whitworth & Company, Limited, for many years, at the age of 53. At the time of his death he was senior joint manager of the engine works department of the Elswick Works.

MR. H. CHAPMAN, the well-known engineer, of 69, Victoria Street, Westminster, London, S.W. The deceased gentleman, who was 73 years of age.

MR. H. E. PRIDMORE, of Chicago, one of the best known men in the American foundry trade. Mr. Pridmore was an inventor of no mean order, and his achievements in the manufacture of harvesting machinery, and for the last 22 years in moulding machinery, place him in the front rank of those who have given their time and study to the development of these problems. Mr. Pridmore was the first to make the stripping-plate moulding machine a commercial success. Other moulding machines he has invented include the rockover drop machines and plain rockover machine.

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PERSONAL.

MR. D. SMITH has been elected managing director of Daniel Smith, Limited, Castle Iron Works, Wolverhampton.

MR. J. HAMILTON, formerly chairman of Robert Napier & Sons, Limited, has joined the board of the Fairfield Shipbuilding and Engineering Company, Limited.

MR. DOUGLAS VICKERS, of the firm of Vickers, Sons & Maxim, Limited, has been installed during the month with all the ancient formalities Master Cutler of Hallamshire.

MR. J. GRIFFITHS, of the Dowlais Works of Guest, Keen & Nettlefolds, Limited, has been appointed as commercial manager of Messrs. Cammell, Laird & Company's Derwent Iron and Steel Works.

MR. F. COLLIER, for some years in the employ of Messrs. Jones & Company, Lionel Street, Birmingham, who has taken a prominent part in the work of the Friendly Society of Ironfounders, has been the recipient of a presentation from the officials and men at the works on the occasion of his leaving to take up a position in India.

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MR. ALFRED WISEMAN, of Glover Street, Birmingham, has purchased the business of Messrs. T. & J. Allen and Messrs. S. C. Parkes & Company, of Coleshill Street, Birmingham, which he has transferred to Glover Street. Mr. Wiseman is now putting down a very up-to-date foundry plant, for the purpose of making heavy weighbridges.

FOUNDRY LADLES.

28 LB.
—to—
30 TON.

JAMES EVANS & CO., BRITANNIA WORKS,

TELEGRAMS—
"LADLES, MANCHESTER."
TELEPHONE—2297

BLACKFRIARS, MANCHESTER.

NEW COMPANIES.

SIMPLEX ENGINEERING COMPANY, LIMITED.—Capital £20,000, to acquire the business of the Simplex Engineering Company, Limited.

HUGHES, FAWCETT & COMPANY, LIMITED.—Capital £15,000, to acquire the engineering business of Hughes, Fawcett & Company, Hebden Bridge.

THOMAS LARMUTH & COMPANY, LIMITED.—Capital £40,000, to acquire the business carried on at Todleben Iron Works, Salford, as Thomas Larmuth & Company.

HAWORTH & HARTLEY, LIMITED.—Capital £2,000, to carry on the business of engineers, founders, etc. Registered office: Holden Vale Iron Works, Haslingden.

J. STANLEY & COMPANY, LIMITED.—Capital £1,000, to take over the engineering business carried on at Addison Street Works, Wednesbury, as J. Stanley & Company.

THOMAS SUMNER & SONS (LIVERPOOL), LIMITED.—Capital £9,000, to acquire the business of engineers, etc., carried on at Victoria Iron Works, Liverpool, by Thomas Sumner & Sons.

ARCHIBALD HUTCHESON, LIMITED.—Capital £7,500, to acquire the business of engineers and ironfounders, carried on by Archibald Hutcheson, Limited, Mair Street, Plantation, Govan.

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Llantrissant, October 25th, 1904.

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Elders Navigation Collieries, LTD. Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1907-8.	1906-7.
Iron—Scotch pig warrants ... ton	*54 6	*63 6
—Middlesbro' warrants ... ... ton	48/5½	51/11
—W.C. M/nos Bessemer ... ... ton	60/0	73/0
—Stock, Scotch, tons	1,000	1,300
Copper—Chili bars, GMB ... ... ton	£61 13/9	£65 12/6
—Stock, Europe & afloat... ... tons	52,245	10,683
Tin—English ingots ton	£133 10/0	£149 10/0
—Straits ... ton	£134 12 6	£147 5/0
—Stock, Ldn. Hind and afloat ... tons	19,073	11,324
Lead—English pig ton	£13/15 0	£18 15 0
Spelter—Ord. Silesian ... ... ton	£20 0 0	£22 0 0
Quicksilver—(75lb.) bottle	£8 10/0	£8 4/6
Antimony—Regulus ... ... ton	£32 10 0 £34 0 0	£42 0 0-£45 0 0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1¼ to 2½ in.	5 2 6	to	5 7 6
„ 3 to 4 in.	4 15 0	to	5 5 0
„ 5 to 8 in.	4 12 6	to	4 15 0
„ 10 to 16 in.	4 12 6	to	4 15 0
„ 18 to 24 in....	4 12 6	to	4 15 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 5s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 6s. 0d.; all per ton f.o.b., London. Copper (clean), £56 0s. 0d.; brass (clean), £39 10s. 0d.; lead (usual draft), £12 15s. 0d.; tea lead, £11 0s. 0d.; zinc, £15 15s. 0d.; all per ton delivered merchant's yard.

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GROUND GANISTER,

Wet or Dry.

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Better than Fire-clay Bricks for Cupolas.

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FOUNDRY EQUIPMENTS,

Composition Black Lead,

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Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

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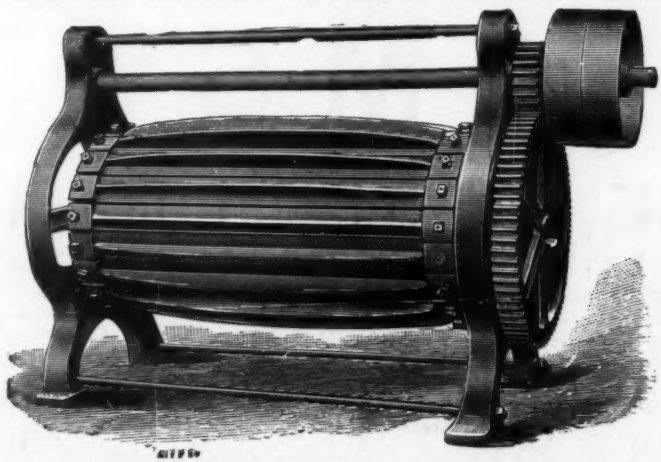

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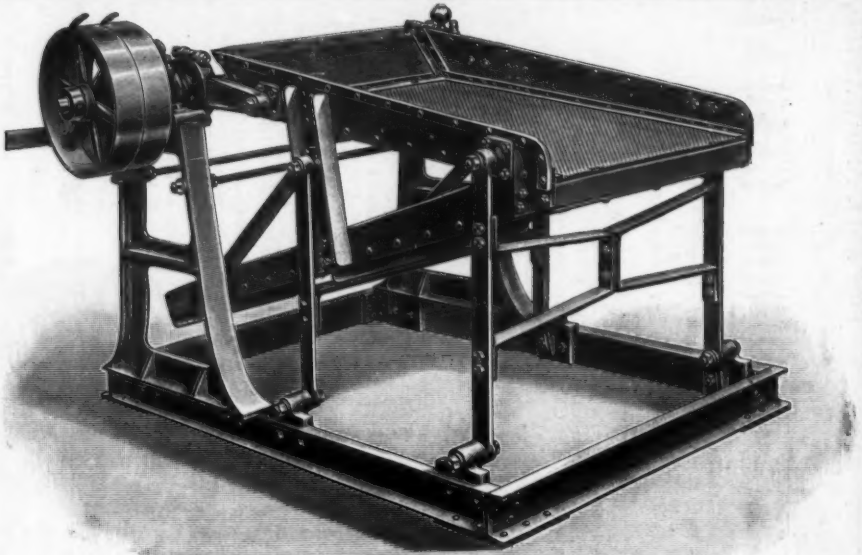

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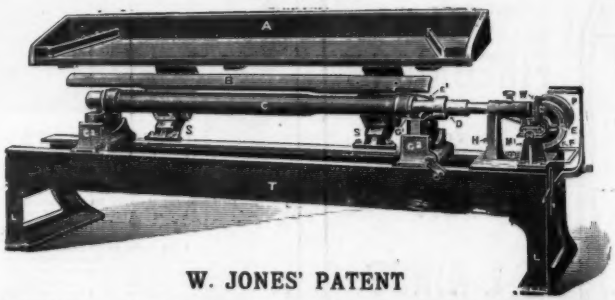

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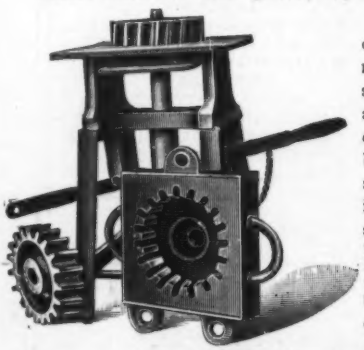

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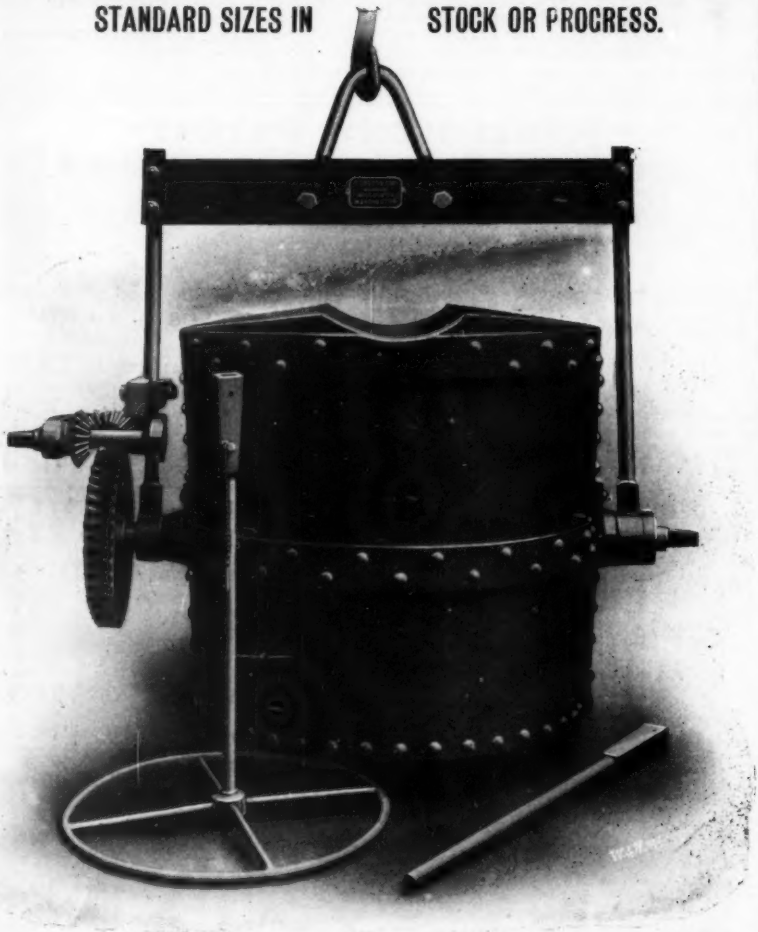

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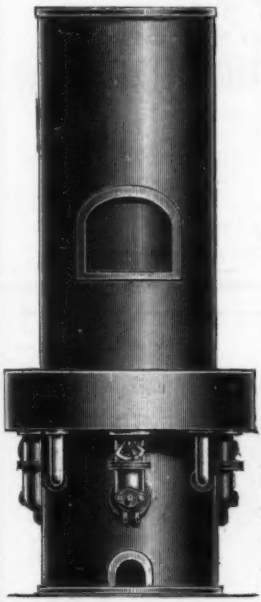

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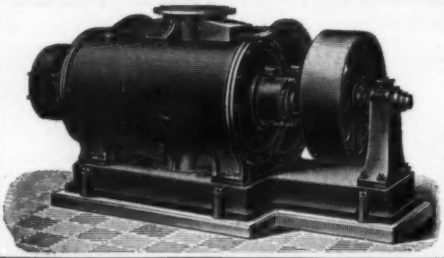

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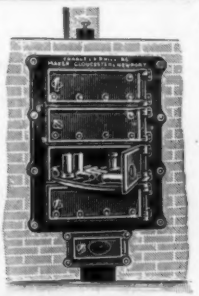

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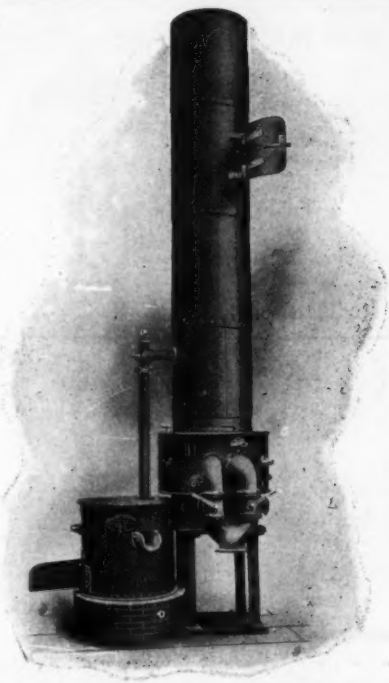

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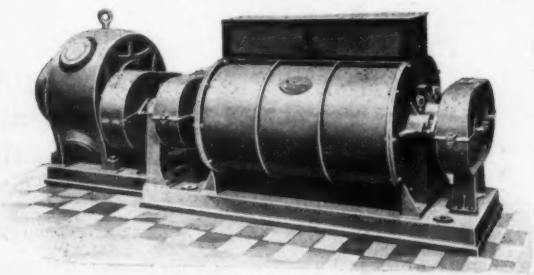

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